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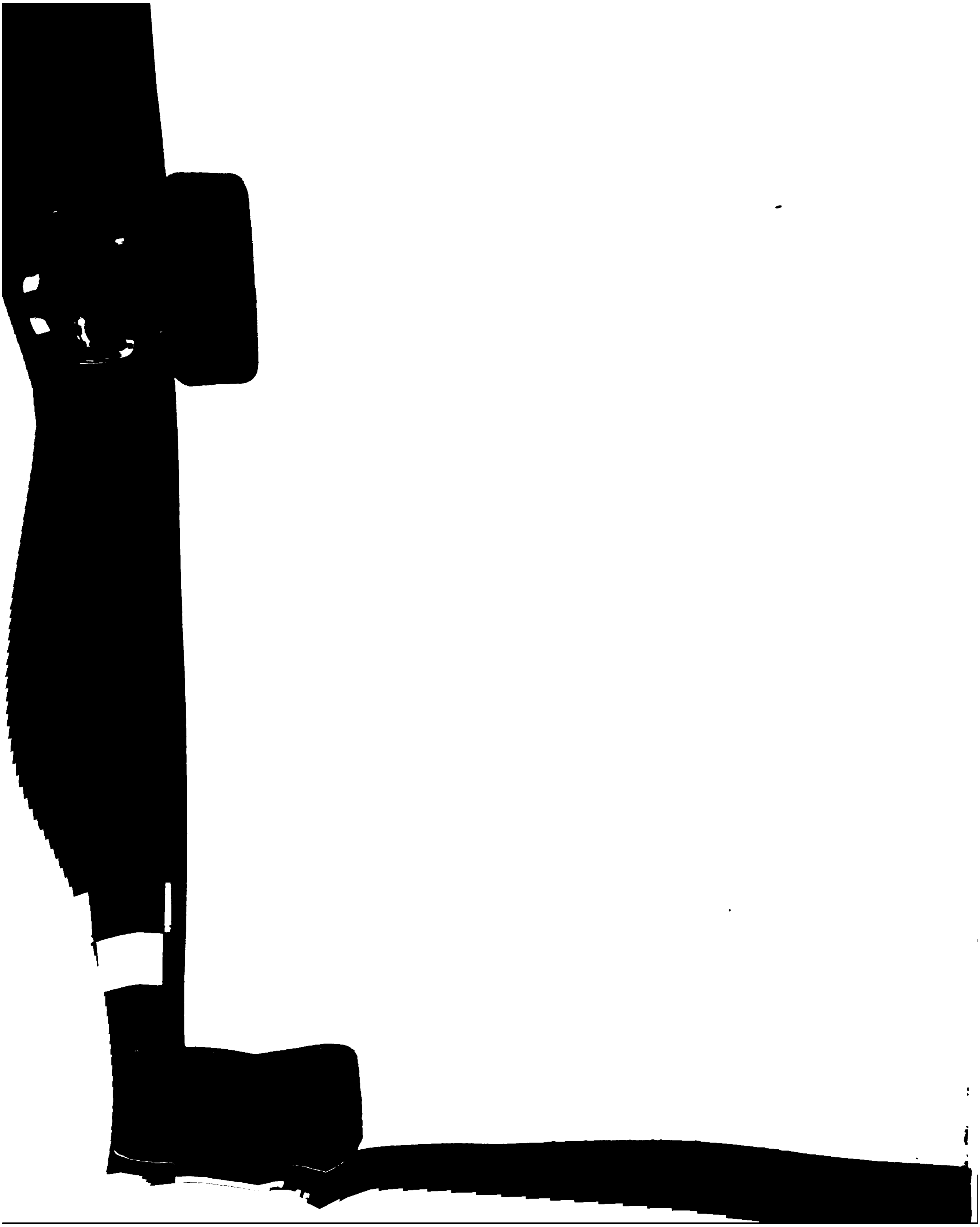

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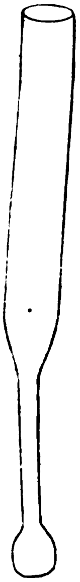

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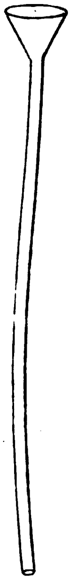

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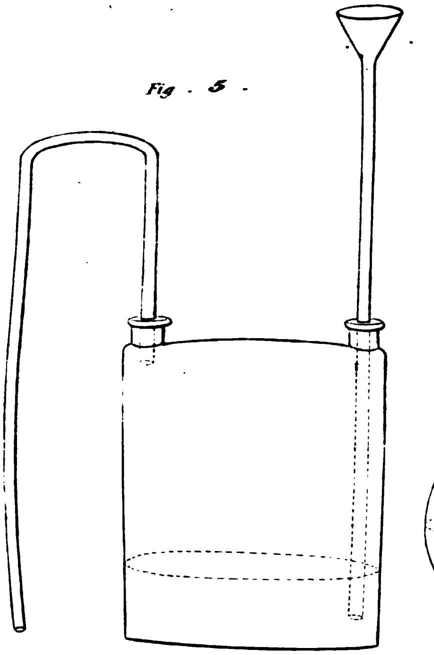

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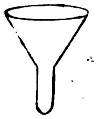

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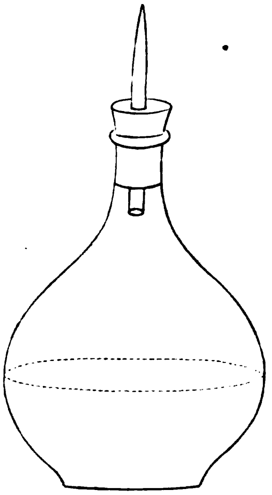

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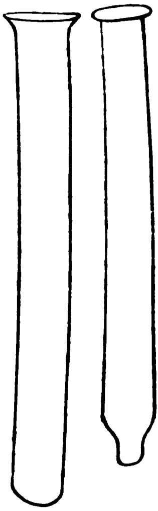

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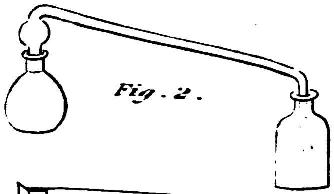

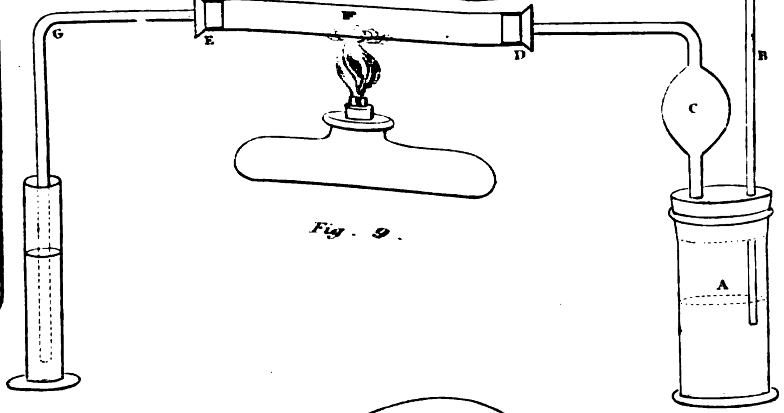

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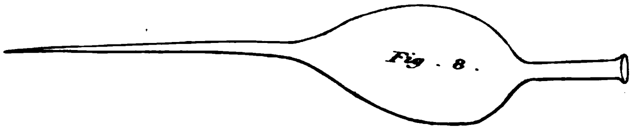

Fig. 8.

Lizars Sculpt

A

TREATISE

ON

POISONS,

IN RELATION TO

MEDICAL JURISPRUDENCE, PHYSIOLOGY, AND THE PRACTICE OF PHYSIC.

BY

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PREFACE

TO THE THIRD EDITION.

THE approbation with which the public has received the Author's previous attempts to add to English Medical literature a systematic Treatise on Toxicology again requires him to express his acknowledgments for its reception, and to prepare a Third Edition embracing the newest improvements in Toxicological science. The discoveries and observations of so short a period as four years, which have elapsed since the last appearance of this work, have enabled him to add many new illustrations of the principles formerly advanced regarding the physiology, symptoms, and pathology of poisoning, to improve in some respects several processes of analysis, and also to introduce a few subjects altogether new. Although the work has in consequence been again considerably extended, it might have been enlarged to a much greater extent had he comprised all the additional facts and illustrations which have come under his notice personally or in the course of reading. The necessity thus entailed of making a selection, while it ought to render the present additions the more valuable, is farther a most gratifying proof of the increasing ardour with which the department of Toxicology is at present cultivated.

Some explanation may be required of a departure from this principle of selection in one division of the subject, that of Chemical Analysis. It would certainly have been desirable, in a work where succinctness is a material object, to confine the reader's attention to a single process for each poison, making choice of that which experience and express trial have shown to be the best among the many which have been lately proposed. The Author endeavoured to institute a course of experiments having this object in view. But he was soon led to abandon them as unsatisfactory and really of less importance than would at first sight appear. For any one who engages extensively in this line of investigation will satisfy himself ere long, that the proposers of processes of analysis for detecting poisons in the mixed state and in minute doses have often imagined their own processes superior to others in previous use, rather because they had acquired more practical skill in the application of them, than because the superiority is real. It has therefore appeared the best plan to give an account of every good new process for the more important poisons, and to point out that which in the Author's experience has answered well,——without, however, pretending to affirm that some of the others may not be equally convenient, delicate, and precise.

October 1835.

PREFACE

TO THE FIRST EDITION.

THE frequency of murder, suicide, and accidental death by poison, the interest usually attached to such events, the nicety of the inquiries by which their nature is brought to light, and the necessity of a comprehensive knowledge of medicine for their elucidation,—render Toxicology, in the eye of all well-informed persons, an important and essential part of the studies of every medical man. This is acknowledged on all hands, so that even in Britain, where the other departments of Medical Jurisprudence are only now forcing their way slowly on public attention, the branch which treats of poisons has been for some time pursued with avidity by the student, and cultivated with success by the scientific physician. In such circumstances it appears surprising, that the present should be the first original and systematic work on the subject, which has been published in the English language since the beginning of the present century.

The object of the science of Toxicology is fourfold. It supplies antidotes for the various poisons; it furnishes the physiologist with valuable instruments of research in his investigations into the laws of the animal economy; it aids the physician in his inquiries as to the action of many energetic drugs; and it collects from the numerous branches of medical knowledge, as well as from collateral sciences, the materials of the most important department of medical jurisprudence.

It is only since Toxicology began to assume an accurate and systematic form, and chiefly since it was matured by the indefatigable labours of *Orfila*, that the physician can truly say he has been in possession of Antidotes. It is to the modern toxicologist that he owes the discovery of the virtues of albumen as an antidote for corrosive sublimate and verdigris,—of bark for tartar-emetic,—of the alkaline sulphates for sugar of lead,—of the alkaline and earthy chlorides for liver of sulphur,—of ammonia and chlorine for prussic acid; it is to the toxicologist that he is indebted for ascertaining the superiority of magnesia and chalk over other antidotes for the mineral acids and oxalic acid, and the superiority of vinegar or oil for the mineral alkalis. It was also a toxicologist who first proposed the application of the stomach-pump in the treatment of poisoning.—These, however, are far from being the only advantages which have been derived from applying this science to the discovery of antidotes. The study of poisons, in their relations to chemistry and physiology, has in the course of a few years expelled from the practice of medicine a host of popular remedies,—the offspring of hasty empiricism,—which, instead of being beneficial, were often not only useless, but even absolutely hurtful. Not to mention the many inert remedies which have thus been consigned to oblivion, I may refer to the late discovery of the bad effects of the alkalis in poisoning with arsenic and oxalic acid,—of the alkaline sulphurets in poisoning with arsenic and other metallic compounds,—of the acetic acid in poisoning with the salts of copper, or with opium and other narcotic vegetables,—and of fixed oil in poisoning with cantharides.

Besides thus discovering many antidotes, and proving the inefficacy of others, the toxicologist has advanced a step farther still, and has saved the physician much unnecessary labour in future, by laying down the general principles by which the search for new antidotes must be regulated.

To those who have watched the rapid strides with which Physiology has advanced during the last twenty years, it will at once be apparent, how powerful an instrument of research that science has found in the effects of poisons on the animal body. The observation of these effects has led in a peculiar manner to our present enlarged knowledge of the laws of absorption. It has greatly aided the experimentalist in ascertaining the respective part performed by the veins and the lymphatics, in the discharge of this function: It has contributed to the discovery of the permeability of the living tissues, and the influence which this property has in producing many of the phenomena of absorption: It has helped to unfold the power exercised by absorption in the developement of many vital actions, which were formerly ascribed to nervous operations: In short, it has been one of the principal guides by which the progress of ***Magendie*** and his followers has been directed in their brilliant career of discovery.

But independently of thus furnishing the physiologist with the means or instruments of investigation, the action of poisons on the body forms of itself a deeply interesting department of physiological science, and one which abounds with important practical conclusions. From the discoveries in this department are deduced many of the general rules for the treatment of poisoning, as well as the solution of some principal questions in medico-legal practice.

I have likewise said, that the science of Toxicology aids the physician in his inquiries into the Action of Remedies. Many of the most valuable remedies for combating disease being in larger doses violent poisons, their action as poisons in some instances, though certainly not in all, throws light on their action as remedies. Thus the direct paralysis, which is produced by opium in the muscular fibres on which it is applied, furnishes an explanation of its influence in spasmodic affections of the bowels. The same paralysing property of sugar of lead appears to account for the beneficial influence of that substance in dysentery. The peculiar tendency of cantharides to excite in poisonous doses inflammation of the urinary organs, accounts for its power as a therapeutic agent in stimulating the bladder. The property possessed by the acrid vegetables, of exciting in poisonous doses violent inflammation of the bowels, explains their purgative qualities when they are given in smaller doses, and likewise the uncertainty of their effects unless they are combined with other milder and more certain laxatives.

The information furnished by toxicology, however, is sometimes more direct, the discovery of remedies in particular diseases having been originally derived from the knowledge of their action as poisons. One substance at least has been introduced in this way into the practice of physic, I mean nux vomica, with its active principle strychnia; and it is not improbable, that, as our knowledge of the operation of poisons becomes more accurate, farther additions may be made in like manner. Nux vomica, it is true, was long used in medicine empirically in various diseases. But it is only since the observations of *Magendie* and *Delille* on its singular power of irritating the spinal chord and nerves, that it has been systematically and successfully resorted to in the treatment of various forms of palsy.

There is yet another reason, which renders Toxicology, in reference to the action of remedies, a subject of primary importance to the physician. The most energetic articles of the Materia Medica being, as already observed, poisons in large doses, it is indispensable to be well acquainted with their deleterious effects, before they can be safely employed in the treatment of disease; and this knowledge is particularly called for in regard to those remedies,—probably not few in number, whose therapeutic effects are not developed till their physiological effects have begun to manifest themselves.

But after all, while these considerations show that Toxicology admits of being extensively applied to other medical sciences, it is in Medical Jurisprudence that its power and extent are most evident.

The Toxicological department of Medical Jurisprudence has been brought of late years to a state of much greater perfection than the other branches of medico-legal knowledge. Its superiority must be chiefly ascribed to the greater care with which medical men have sifted its fundamental principles,—their attention having been naturally turned in that direction in consequence of their duties being more difficult and of their opinions having more influence in this than in any other variety of judicial proceedings. In cases of poisoning many causes combine to concentrate the weighty part of the proof in the medical evidence. The proof of the fact, or of death having been occasioned in the manner alleged, can very seldom be drawn, as in other kinds of homicide, from general evidence or from any thing else than medical testimony. This evidence is the more important, that the proof of poisoning also commonly infers proof of the intent. For on such trials it is impossible, as on other trials, to entertain the question, whether death was the consequence of deliberate purpose, or of sudden fury, or of an act of self-defence? In the few cases too where the proof of the fact does not at once infer the intent, the intent is sometimes established by medical evidence. When the prisoner, for example, maintains that he gave the poison by mistake, it may be proved by chemical analysis or otherwise, as in a remarkable instance mentioned in the course of this work*, that it was impossible any accident of the kind alleged could have happened.—These circumstances should tend to render the physician the most material witness on trials for poisoning; and that he is really so must appear obvious, when we look either to the share his examination occupies of the judicial proceedings, or to the variety of questions referred to his decision, or to the influence of his opinions on the issue of the case.

Since so much appears to depend on him, it is fortunate that his resources are in a corresponding degree extensive. These resources are derived from the sciences of Semeiology, Pathology, Chemistry, and Physiology. By means of the first he ascertains the differences between the symptoms of poisoning and of natural disease: By the second he distinguishes the appearances in the dead body indicative of death by poison from those of natural death: The third enables him to discover foreign substances of a deleterious nature in the body and elsewhere: And the fourth instructs him how to determine the value of evidence from the accidental effects of suspected substances on domestic animals, as well as to apply express experiments on animals to settle by analogy doubtful questions relative to the operation of poisons on man. The object of Toxicology, then, as a branch of Medical Jurisprudence, is to imbody all this information into one science. It ranges over the whole vast field of medical learning, and draws together from a variety of quarters facts and principles which are seldom at any other time viewed in combination. The resources of each science are thus made to try the accuracy and supply the defects of the others; and the whole mass of knowledge is brought to bear in one direction with a force and precision worthy of its objects,—the detection of crime, and the vindication of innocence.

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* See p. 82.

Having now stated my ideas upon the objects and importance of the science of Toxicology, I shall proceed to mention the views which have directed me in the composition of the present treatise.

Since my appointment to the chair I hold in this University, it has been my fortune to be more extensively engaged in the practice of the toxicological department of medical jurisprudence, than I believe ever fell to the lot of any physician in this country. At an early period it appeared to me, that on some practical points the existing works on poisons were deficient in a degree which was scarcely to be expected, considering their high reputation and scientific excellence. Some inquiries of frequent occurrence on trials for poisoning I found not noticed at all; and others were so cursorily handled that I could not suppose the authors were aware of their importance in practice. These defects have probably arisen from the attention having been too exclusively turned to the means by which particular poisons may be proved to have been the cause of death; whereas the questions which actually occur in medico-legal practice are much more diversified. In order to discover and remedy the defects alluded to it is necessary to consider what are the inquiries which the medical jurist has to conduct in questions of poisoning.

When poisoning is suspected, the aid of the physician may be required on two occasions,—in the investigations carried on by the Sheriff in Scotland, or Coroner in England,—and on trials before the high criminal courts.

In the former the purpose of his opinion is commonly to determine the propriety of farther proceedings. Here he has very often to inquire into cases which are really instances of natural death, but which in peculiar circumstances have given rise to a suspicion of poisoning. Hence, while he must on the one hand be prepared to prove in some cases that death has arisen from poison, he must on the other hand be also sometimes ready, not only to give the mere negative opinion, that there is no satisfactory proof of poisoning, but likewise to declare that death has positively arisen from natural disease. In cases of this kind, it often happens, that no particular poison is indicated. There is merely a general suspicion or charge of poisoning of some kind or another; and even although no particular poison may be found, the physician is required to say, whether there is a certainty, probability, or possibility of poisoning *in a general sense.*

For the elucidation of these questions, which have received but little attention from authors, I have dwelt at considerable length in the present treatise on the Evidence of General Poisoning. It is unnecessary to state here the substance of the chapter on this topic; but the reader will find in it inquiries which have not been entered into in any other work, and which it is hoped will be found practically useful. I have especially endeavoured to keep always in mind, that in many cases the chief object is to establish the impossibility of poisoning, and to silence vague rumours or plausible suspicions,—a point to which few toxicological writers have directed much of their regard. In the same chapter some remarks have been made on the mode in which medical evidence sometimes traces the administration of poison to a particular individual, illustrates his intent, and throws light on various other particulars of the general evidence.

On trials before the high criminal courts the medical witness is somewhat differently placed. While he ought to be always prepared to give full effect to every medical circumstance favourable to the prisoner, he should at the same time recollect that very few trials indeed take place in Britain, where it is not in the highest degree probable that poison was given; and consequently, that the main purpose of his inquiries must be to bring together the whole medical evidence to this effect, and to secure it against the doubts which the ingenuity of counsel is sure to throw over his conclusions, if the premises are any where false or defective.

On such trials the prisoner is usually charged with administering a particular poison, and also some poison unknown to the prosecutor. In some instances the evidence of the particular poison is merely presumptive; and the presumption may not be strong, so that the charge is substantially one of poisoning in a general sense. And indeed convictions have been recently obtained under such charges where no satisfactory proof existed what poison had been given *. In the chapter on the Evidence of General Poisoning, and in the two chapters on the diagnosis between the effects of natural disease and those of the Irritant and Narcotic classes of poisons, I have endeavoured to instruct the physician

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* See the case of *Mary Anne Alcorn,* pp. 77, 86, and a German case, p. 62.

in cases of this kind. For I cannot agree with the opinion, expressed by all German and most French authors in medical jurisprudence,—that poisoning can never be completely substantiated unless the particular poison be found out. It is very likely that the proof of general poisoning from medical evidence alone can never amount to more than a strong probability. But the medical probability may be so high, that, in conjunction with other circumstances of general evidence, no rational being can entertain a doubt that poisoning has been perpetrated.

Much more frequently, however, on trials before the high criminal courts, the evidence is pointedly directed towards proving the administration of a particular poison. Here the medical witness draws his evidence from four distinct sources,——the chemical analysis, the morbid appearances in the dead body, the symptoms during life, and sometimes the physiological effects of the suspected poison on animals. In treating of the poisons individually, I have endeavoured to follow this natural arrangement.

In considering the Chemical evidence, it has been my invariable object to select processes, which are at the same time delicate, conclusive, and easily managed by the inexperienced. I have never lost sight of the fact, (which cannot be too much impressed on the medico-legal chemist, and which renders all the early modes of analysis useless,) that the search for poisons must be chiefly carried on in the most complex mixtures, and where the quantity of the poison is small. I may add, that there are very few of the processes recommended in this work, whose accuracy I cannot vouch for, in consequence of frequent trials made under the most difficult circumstances. Some of the processes are new, and preferable, so far as my own experience will allow me to judge, to any previously proposed for the same purposes. These are chiefly the process for Arsenic, that for Mercury, and that for Opium ; but some improvements have also been suggested in the mode of detecting Copper, Lead, Zinc, and Oxalic acid. In one chapter, that on Lead, I have extended my remarks on the chemistry of the subject farther perhaps than was called for in a strict treatise on medical jurisprudence. I had made some experimental researches on the action of various waters on lead ; and as the results appeared to me interesting, and form an essential part of a kindred branch of knowledge, medical police, I conceived that a statement of them might not be misplaced in the present work.

The Physiological effects of each poison on animals then come under consideration, and are succinctly stated in an inquiry into its mode of action, as preliminary to the detail of its effects on man.

In treating of the Symptoms observed in man, I have preferred giving a general account of the effects of each poison to transcribing a list of complete cases, as Professor Orfila has done. I have thus been enabled to communicate more information in much less space. Great care, however, has been taken to specify all the deviations from the usual course of the symptoms, and likewise to classify the ordinary cases according to the leading varieties. In the classification of cases the reader will perceive a few novelties have been introduced, which it is hoped will be found improvements.—Some pains have been bestowed on two points, which systematic writers on poisons have utterly neglected,—the shortest and longest intervals within which poisons begin to operate, and the shortest and longest period within which they prove fatal. In relation to these points, questions not infrequently occur in trials, where the fate of the prisoner may depend on the answers returned by the medical witness*; yet no information of the kind is to be met with in any systematic work on toxicology. In the present treatise, I have attempted to ascertain with precision the commencement and duration of the symptoms of most of the common poisons. But it is necessary to observe, that precise information as to these points is not often to be found in the narratives of cases; and hence that in all probability some of the statements made in this work will subsequently require to be modified. Another point which it has been considered proper to investigate with more care than has hitherto been attempted, is the diagnosis between poisoning and natural disease, as founded on symptoms only. Almost all modern writers on medico-legal toxicology have declared such diagnosis impossible; and their opinion is undoubtedly correct, as a general rule. But at the same time, the more the subject is inquired into, the more strongly does it appear to me that the rule admits of certain special exceptions, which it is of great consequence to indicate distinctly†. It was perhaps natural, that the former loose practice of deciding questions of poisoning almost always from symptoms only, should not be corrected without passing as far into the opposite extreme. But it is now time to return to the mean, where, as in other matters, the truth may be presumed to lie. This I have attempted to do; without the presumption, however, of thinking that future experience will not render necessary some modification of the opinions here hazarded. It would be surprising if no errors were committed upon questions which must be decided, not by one man's experience or reading, but by the experience and learning of the whole medical profession.

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* See cases of Smith, 279; Freeman, 704; Russell, 284; Crown Prince of Sweden, 47.

† See pages 164, 207, 304, 400, 804.

The subject of the Morbid Appearances left in the dead-body by poisons, has been considered nearly in the same manner with the preceding topic. Every appearance mentioned by good authorities has been noticed, even where the accounts of different authors are apparently contradictory; and an attempt has sometimes been made to reconcile the discrepancies, by classifying the appearances according to certain varieties in the features of the cases during life. In this department of the work much difficulty has been encountered, from the vague and incorrect language often used by authors.

In some instances, I have endeavoured to show that the morbid appearances will, when taken alone, form the grounds of a diagnosis between poisoning and natural disease. Such cases, however, must be admitted to be rare.

To these strict medico-legal investigations, a short view has been annexed of the Treatment of the principal varieties of poisoning. To the physician this is of obvious utility, and to the medical jurist it is necessary, in order that he may be able to answer questions as to the treatment in particular cases.

Throughout the whole work, I have turned my personal experience as much to account as was in my power. But in medical jurisprudence, more than in any other medical science, the experience of any single individual, how great soever it may be, is but a feeble light to guide his steps, when compared with the vast accumulated stores of the records of medicine. These I have made use of to the best of my ability; and I have had such unbounded access to authorities, that the chief difficulty has lain in the selection. I believe the present is the first attempt to make known beyond the precincts of Germany, the admirable collection of facts contained in the numerous medico-legal periodicals of that country. The reader, after perusing any one of the chapters on special poisons, will be able to judge for himself whether the want of such a source of information could be compensated by access to any other. To the numerous French authorities, recourse has also been had for many of the most valuable facts of toxicological science, particularly in the physiological and chemical departments, in which the physicians and medical jurists of that country have always been labouring indefatigably and with success. I have not referred often to Italian authorities; but if a judgment may be formed from the works which I have perused, the deficiency is not much to be regretted. Our own language abounds in interesting facts relative to the medical jurisprudence of poisons; but the information is scattered throughout such an infinity of sources, that it is not improbable some part of it may have escaped my search. In the quotations, reference has been made, with very few exceptions, to the original authorities. This precaution, a proper one in every circumstance, is doubly called for in a medico-legal work: for in Scotland a witness is allowed to support his opinion by express reference to published authorities; and there is little doubt that the same practice will by and bye supersede the present absurd banishment of authorities from the English system of medical evidence.—The reader may perhaps think, that I have confined myself too much to modern authors, and paid too little respect to the opinions of the older writers. But in medical jurisprudence, above all the other medical sciences, it has appeared to me that the precision and accuracy of facts generally follow the inverse ratio of their antiquity; and such being the case, so long as there is abundance of modern instances, I see no reason for quoting the authors of past centuries.—In the chemical department I fear facts have not been so often referred, as might have been done, to their original observers. My reason is partly, that if this had been always attended to, the work would have been considerably extended by the necessity of stating the claims of various experimentalists; and partly, that many facts in chemistry are now so familiar and so well established, that they have almost ceased to be identified as the property of their discoverers.

In singling out the species of poisons for examination, I have confined myself in a great measure to the poisons which occur in Britain; and it is only the most common of these that have been minutely investigated. Had my views been extended to all poisons with the same minuteness, the work could not have been confined within its present dimensions. One or two poisons of foreign origin, and which are hardly ever met with in this country, have been noticed on account of their importance in the countries where they occur, and the extent and accuracy of the researches which have been made on their nature. Some species were omitted in the text, which I now think ought to have been noticed, and which I have not added in the appendix, because I was unwilling to make it long and unwieldy. The chief of these are *Emetine*, the *Chlorides of lime and soda*, *Bromine*, *Laburnum*, and the poison of *Rabies*.

Several investigations of great consequence to the medico-legal toxicologist have not been entered on, because they relate to medical jurisprudence generally, not to Toxicology in particular, and have never been considered in works on poisons. Among these may be specified the subject of pseudo-morbid appearances, and that of the signs, causes, and circumstances of natural death.

Orfila first introduced, and several authors have copied from him, a long methodical table of all poisons, with their properties so arranged, that a suspected substance might, by a successive comparison of its qualities, be referred to its proper head among them. But as in nineteen cases out of twenty the poison is presented to the medical jurist in so impure a state that this mode of examination is inapplicable; and as it is very doubtful whether an unknown poison is ever in actual practice found out in such a manner, I have omitted the table altogether. By moral evidence and the consideration of the symptoms, the particular poison is always indicated presumptively: and the analysis is directed by this presumption.

November, 1829.

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PART FIRST.

OF GENERAL POISONING.

CHAPTER I.

ON THE PHYSIOLOGICAL ACTION OF POISONS.

I SHALL discuss this subject by considering first the mode in which poisons act, and secondly, the causes by which their action is liable to be modified.

SECTION I.—*On the Mode of Action of Poisons.*

When we attend to the effects which follow the application of a poison to the body we perceive that they are sometimes confined to the part where it is applied, and at other times extend to distant organs. Hence the action of poisons may be naturally considered as *Local* and *Remote.*

The Local effects of poisons are of three kinds. Some decompose chemically or corrode the part to which they are applied. Others, without immediately injuring its organization, inflame or irritate it. Others neither corrode nor irritate, but make a peculiar impression on the sentient extremities of the nerves, unaccompanied by any visible change of structure.

We have examples of local *corrosion* or chemical decomposition in the effects of the concentrated mineral acids or alkalis on the skin, and in the effects of strong oxalic acid, lunar caustic, or corrosive sublimate on the stomach. In all of these instances the part to which the poison is applied undergoes chemical changes, and the poison itself often undergoes chemical changes also. Thus oxalic acid dissolves the gelatin of the animal textures; and in the instance of corrosive sublimate, the poison is converted into calomel, which unites with the albumen, fibrin, and other principles of the tissues.

Of local *irritation* and its various consequences we have many examples, from redness, its slightest, to ulceration and gangrene, its most severe effect. Thus externally, alcohol reddens the skin; cantharides irritates the surface of the true skin and causes vesication; tartar emetic causes deep-seated inflammation of the true skin and a pustular eruption; the juice of manchineel* spreading inflammation of the subcutaneous cellular tissue; arsenic all of these effects, as also death of the part and subsequent sloughing. Internally, alcohol reddens the stomach, as it does the skin,—but more permanently; while other substances, such as the diluted mineral acids, nitre, arsenic, cantharides, euphorbium, and the like, may cause all the phenomena of inflammation in the stomach and intestines, namely, extravasation of blood, effusion of lymph, ulcers, gangrene. Many of these irritants, such as arsenic, are in common speech called corrosives; but they have not any power of causing chemical decomposition: If they produce a breach in the texture of an organ, it is merely through the medium of inflammation and its effects.

Of *nervous impressions*, without any visible organic change, few well authenticated and unequivocal instances are known. *Mr Brodie* mentions a good example in the effects of monkshood on the lips when chewed†: it causes a sense of numbness and tingling in the lips and tongue, lasting for some hours, and quite unconnected with any affection of the general nervous system. Another instance, which was mentioned to me by *M. Robiquet* of Paris, occurs in the effects of the strong hydrocyanic acid: When its vapour was confined for some time in a glass tube with a finger on each open end, M. Robiquet remarked, that the point of each finger became benumbed and remained so longer than a day. These are unequivocal instances of a purely nervous and local impression on the external surface of the body. The most unequivocal instance I know of a similar impression on internal parts is a fact related by *Dr W. Philip* with regard to opium [*]. When this poison was applied to the inner coat of the intestines of a rabbit during life, the muscular contractions of the gut were immediately paralyzed, without the general system being for some time affected. The same effect has been observed by *Messrs Morgan and Addison* to follow the application of ticunas to the intestine [†]: An instant and complete suspension of the peristaltic movement took place as soon as it touched the gut. A parallel fact has also been described by *Dr Monro, secundus* [‡]: When an infusion of opium was injected between the skin and muscles of the leg of a frog, that leg soon became palsied, while the animal was able to leap briskly on the other three. Analogous results have farther been obtained with the prussic acid by *M. Coullon* [§]. He remarked, that when one hind-leg of a frog was plunged in the acid, it became palsied in thirty-five minutes, while the other hind leg continued perfectly sensible and irritable. Sugar of lead probably possesses the same property.

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* *Orfila* and *Ollivier*, Archives Générales de Médecine, x. 360.

† Philosophical Transactions, 1811, 186.

These facts are important, because some physiologists have doubted whether there really exist any local impressions of a purely nervous nature, unconnected with appreciable organic change, and arising from the action of poisons. Yet the existence of impressions of the kind is essential to the stability of the doctrine of the sympathetic operation of poisons,—that is, of the transmission of their influence from organ to organ along the nerves. Nay, in the instance of very many poisons supposed to act in that manner, we must still farther believe in the existence of primary nervous impressions, which are not only unconnected with organic change, but likewise undistinguishable by any local sign whatsoever.

Of the three varieties in the local effects of poisons—corrosion, irritation, and nervous impressions,—the first two may take place in any tissue or organ; for example, they have been observed on the skin, on the mucous membrane of the stomach, intestines, windpipe, air tubes, bladder and vagina, in the cellular tissue, in the serous membranes of the chest and abdomen, in the muscular fibre. We are not so well acquainted with the nature of local nervous impressions on different tissues; but it is probable that in some textures of the body they are very indistinct.

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[*] Experiments on Opium, 1795, reprinted in his Treatise on Fevers, iv. 697.

[†] Essay on the operation of poisonous agents on the living body, 1829, p. 68.

[‡] Edin. Phys. and Lit. Essays, iii. 311.

[§] Recherches sur l'acide hydrocyanique, 1819, p. 179.

So much for the local effects of poisons.

On tracing the phenomena which follow more remotely, we observe, that the affected part sometimes recovers without any visible change, sometimes undergoes the usual processes consequent on inflammation, sometimes perishes at once and is thrown off; and if the organ is one whose function is necessary to life, death may gradually ensue, in consequence of that function being irrecoverably injured. The purest example of the last train of phenomena is to be seen in the occasional effects of the mineral acids or alkalis: Death may take place simply from starvation, because the inner surface of the stomach and intestines is so much injured that they cannot assimilate a sufficient quantity of nutriment.

But death and its antecedent phenomena can seldom be accounted for in this way. For symptoms are often witnessed, which bear no direct relation to the local injury: death is generally too rapid to have arisen from the function of the part having been annihilated: and the rapidity of the poisoning is not proportional in different cases to the local injury produced. Even the mineral acids and alkalis do not always, or rather seldom do kill by impeding or annihilating digestion, because they often prove fatal in a few hours; and among the other poisons there are few which ever cause death simply by disturbing the function of the part primarily acted on. Death and the symptoms preceding it arise from an injury of some other organ, to which they are not and cannot be directly applied. We are thus led to consider their *Remote* action.

The term *remote* is here used in preference to the more common phrase *general* action, because the latter implies an action on the general system or whole body; whereas it appears probable that an action of such a kind is rare, and that most poisons which have an indirect action exert it on one or more of the important organs only, and not on the general system.

There is not a better instance of the remote action of poisons than oxalic acid. It has been already mentioned that concentrated oxalic acid is a corrosive: yet it never kills by destroying the function of the stomach. Man, as well as the lower animals, will live several days or weeks without nutriment. Now this poison has been known to kill a man in ten and a dog in three minutes. Neither does it always induce, when swallowed, symptoms of an injury of the stomach; for death is often preceded by tetanus, or apoplexy, or mortal faintness. Nor is the violence of the poisoning proportional to the extent of the local injury. In fact, death is most rapid under circumstances in which the stomach is least injured, namely, when the acid is considerably diluted.*

Let us now proceed to inquire, then, in what way the influence of a poison is conveyed from one organ to another.

Here it will at once be perceived that the conveyance can be accomplished in one of two ways only. Either the local impression passes along the nerves to the organ secondarily affected; or the poison enters the bibulous vessels, mingles with the blood, and passes through the medium of the circulation. In the former way poisons are said to act through *Sympathy*, in the latter, through *Absorption.*

1. *On the action of Poisons through Sympathy.* In the infancy of toxicology all poisons were believed to act through sympathy. Since *Magendie's* discoveries on venous absorption the favourite doctrine has on the other hand been, that most, if not all, act through the medium of the blood. But the latest researches tend rather to show that a few poisons act by sympathy without entering the blood, and that, although many poisons do enter the blood, the operation even of these may nevertheless consist of an impression made on the sentient extremities of the nerves and conveyed thence along their filaments to the brain or other organs.

The nerves certainly possess the power of conveying from one organ to another various impressions besides those of the external senses. This is shown by many familiar phenomena; and in reference to the present subject, is aptly illustrated by the remote or sympathetic effects of mere mechanical injury and natural disease of the stomach. Acute inflammation of the stomach generally proves fatal long before death can arise from digestion being stopped; and it is accompanied with symptoms, neither attributable to injury of that function, nor belonging in so marked a degree to the phenomena of inflammation in other organs. These symptoms and the rapid death which succeeds them are vaguely imputed to the general system sympathizing with the affected part; but it is more probable that one organ only is thus, at least in the first instance, acted on sympathetically, namely, the heart. The effects of mechanical injuries are still more in point. Wounds of the stomach may prove fatal before inflammation can begin; rupture from over-distension may cause instant death; and in either case without material hemorrhage.

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* Experimental Inquiry on poisoning with oxalic acid. By *Dr. Coindet* and myself—Edin. Med. and Surg. Journal, xix. *passim.*

These observations being held in view, it is impossible to doubt, that some organs sympathize with certain impressions made on others at a distance; nor can we imagine any other mode of conveyance for these impressions except along the nerves. The question, then, comes to be what are the impressions that may be so transmitted?

The statements already made will prepare us to expect a sympathetic action in the case of poisons that manifestly injure the structure of the organ to which they are applied. In the instance of the pure Corrosives its existence may be presumed from the identity of the phenomena of their remote action with those of natural disease or mechanical injury. It was stated above that the mineral acids when swallowed often prove fatal in a very short space of time; and, as in mere injury from disease or violence, so here the symptoms are an imperceptible pulse, fainting, and mortal weakness. Remote organs therefore must be injured; and from the identity of the phenomena with those of idiopathic affections of the stomach, even if there were no other proof, it might be presumed that the primary impression is conveyed along the nerves. We are not restricted, however, to such an argument: The presumptive inference is turned to certainty by the effect of dilution on the activity of these poisons. Dilution materially lessens or even takes away altogether the remote action of the mineral acids. Now dilution facilitates, instead of impeding their absorption: consequently they do not act on remote organs through that channel. There is no other way left by which we can conceive them to act, except by conveyance of the local impression along the nerves. —As to the irritants that are not corrosive, it can hardly be doubted, since they inflame the stomach, that the usual remote effects of inflammation will ensue, namely, a sympathetic injury of distant organs.

It remains to be considered, whether distant organs may sympathize with the peculiar local impressions called Nervous, —which are not accompanied by any visible derangement of structure. This variety of action by sympathy is the one which has chiefly engaged the attention of toxicologists; and it has been freely resorted to for explaining the effects of many poisons.

In regard to one poison, the prussic or hydrocyanic acid, the existence of such a mode of action is, I apprehend, clearly established by the amazing rapidity of its effects. *Mr Brodie* has stated[*], that a drop of the essential oil of bitter almonds, which owes its power to the hydrocyanic acid, caused convulsions instantly when applied to the tongue of a cat; and that happening once to taste it himself, he had scarcely applied it to his tongue when he felt a singular uneasiness in the pit of the stomach, and sudden momentary feebleness of his limbs so that he could hardly stand. *Magendie*[†] goes still farther in his description when speaking of the effects of the pure acid: he compares it in point of swiftness to the cannon-ball or thunderbolt. These accounts of its rapidity may be objected to as vague and even figurative. But they are abundantly borne out by the more definite statements made on a late important trial, that of Freeman for the murder of Judith Buswell, upon which *Dr Freer*, and *Messrs Macaulay*, *Paget*, *Wilkinson*, and *Needham*[‡] deposed that, in the course of certain experiments with the diluted acid, instituted to decide the true rapidity of the poison, several dogs were brought under its influence in ten, eight, five, and three seconds. They are also borne out by some careful experiments I have performed for the same purpose; for among other results I remarked in one instance that an animal was killed outright in four seconds[§]. Another poison is believed by some to be similarly circumstanced, namely strychnia, the active principle of nux vomica. *Pelletier* and *Caventou* have seen it begin to act in fifteen seconds[*]. Alcohol, according to *Mr Brodie*[†], also acts on animals with equal quickness; for, when he introduced it into the stomach of a rabbit, its effects began when the injection was hardly completed. Now, possibly in all these instances, and certainly in the first, the quickness of the action of the poison is incompatible with its having followed the circuitous route of the circulation in order to reach the organ it acts upon; and there is no other conceivable mode by which it can act, except by the transmission of a primary local impulse along the nerves.

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[*] Philosophical Transactions, 1811, p. 184.

[†] Annales de Chim. et de Phys. vi. 349.

[‡] Report of the trial in London Medical Gazette, viii. 796–8.

[§] See subsequently the chapter on Hydrocyanic acid.

The same criterion has not hitherto been satisfactorily applied to prove the existence of a sympathetic action in the case of other poisons. They have appeared to act much more slowly,— so slowly at least, that absorption might easily account for their operation. The supposed criterion of the mode of action of poisons, which has been derived from the degree of rapidity with which they begin to act, has been shown in recent times to be much more fallacious than it was considered to be before physiologists were aware of the singular rapidity with which absorption may take place, and the absorbed matter be conveyed from one part of the body to the other. According to the researches of *Dr Hering* of Stuttgardt, who has made the latest and best experiments on the subject, when the ferrocyanate of potass is injected into one jugular vein in the horse, it may be found by its proper tests in the course of twenty or thirty seconds in the jugular vein of the opposite side, the external veins of the chest, and even the saphena vein of the hind-leg,—in between two and fifteen minutes on the surface of the serous membranes of the chest and belly,—after a somewhat longer period on the surface of the mucous membrane of the stomach and intestines,—and in a single minute throughout the substance of the kidneys[‡]. Keeping these facts in view, it may safely be said, that with the exception of hydrocyanic acid and perhaps one or two other substances, poisons do not act so quickly, that the rapidity of their action is irreconcilable with its taking place through the medium of absorption.

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[*] Annales de Chim. et de Phys. xxvi. 54.

[†] Philosoph. Transactions, 1811, p. 182.

[‡] Zeitschrift für die Physiologie, iii. 1. 81.

f the action of Poisons through Absorption. Under this
ill be stated, first, the leading facts that have been ad-
l in support of the action of poisons through the blood;
the mode in which these facts may be explained away by
who support the doctrine of action by sympathy; next,
n positive objections which are conceived to stand against
rmer doctrine; and lastly, a general view of the newest
ons respecting the universal application of the latter.

isons are believed to act through the blood for the fol-
ng reasons. First, they disappear during life from the
cavities into which they have been introduced; that is,
are absorbed. Several clear examples to this effect are
ted in the essay by *Dr Coindet* and myself on oxalic acid.
one experiment four ounces of a solution of oxalic acid were
cted into the peritonæal sac of a cat, and killed it in four-
n minutes; yet, on opening the animal, although none of
fluid had escaped by the wound, we found scarcely a drachm
naining*.—Next, many poisons act with unimpaired rapi-
y, when the nerves supplying the part to which they are ap-
ied have been previously divided, or even when the part is
tached to the body by arteries and veins only. *Dr Monro,*
cundus, proved this in regard to opium †; and the same fact
as been since extended by *Mr Brodie* and *Professor Emmert* to
oorara ‡, by *Magendie* to nux vomica §, by *Coullon* to hydro-
yanic acid ||, by *Charret* to opium ¶, and by *Dr Coindet* and
nyself to diluted oxalic acid **. Magendie's experiment was
he most precise of all: for, besides the communication with
the poisoned part being kept up by a vein and an artery only,
these vessels were also severed and re-connected by two quills.
—Farther, many poisons will not act when they are applied to
a part of which the circulation has been arrested, even although
all its other connexions with the body have been left entire.
This has been shown distinctly by *Emmert* in regard to the hy-

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* Edin. Med. and Surg. Journal, xix. 335.
† Edin. Phys. and Lit. Essays, iii. 334.
‡ Philosophical Transactions, 1811, 198; and Archiv für Anatomie und Physiologie, iv. 192.
§ Sur le Mechanisme de l'Absorption, 1809; republished, in Journ. de Physiol. i. 26.
|| Recherches sur l'Acide Hydrocyanique, 180. ¶ Revue Médicale, 1827, i. 515.
** Edin. Med. and Surg. Journal, xix. 173.

drocyanic acid; which, when introduced into the hind-leg of an animal after the abdominal aorta has been tied, will not act till the ligature be removed, but then acts with rapidity*. A fact somewhat analogous has been established by the same experimentalist in regard to the woorara: He found that it does not act when introduced into the limb of an animal connected with the body by nerves alone †.—Again, many poisons act with a force proportional to the absorbing power of the texture with which they are placed in contact. This is the criterion which has been commonly resorted to for discovering whether a poison acts through the medium of the blood. It is applicable, however, only when the poison acts sensibly in small doses; for those which act but in large doses cannot be applied in the same space of time over equal surfaces of different textures. The difference in the absorbing power of the different tissues has been well ascertained in respect to a few of them only. The most rapid channel of absorption is by a wound, or by immediate injection into a vein; the surface of the serous membranes is a less rapid medium, and the mucous membrane of the alimentary canal is still less rapid. Now it is proved of very many poisons, that their activity when applied in similar circumstances to these several parts or tissues is proportional to the order now laid down.—Lastly, of one poison, namely nux vomica, it has been proved, that if the extract be thrust into the paw of an animal after a ligature has been tightened round the leg so as to stop the venous, but not the arterial circulation of the limb, blood drawn from an orifice in a vein between the wound and the ligature, and transfused into the vein of another animal, will excite in the latter the usual effects of the poison, so as even to cause death; while, on the contrary, the animal from which the blood has been taken will not be affected at all, if a sufficient quantity is withdrawn before the removal of the ligature. These interesting facts, which are capable of important practical applications, were ascertained not long ago by *M. Vernière* ‡.

To these strong arguments the physiologists who deny the action of poisons through absorption reply,—that the disapnce of a poison from shut sacs into which it has been in- ced, as well as the ingenious experiment of Vernière, ely proves, that poisonous substances in the course of their on enter the blood, but by no means that they are carried g with the blood to the organs on which they act, or that r being so carried is necessary to their action. If by the e test which has been adopted by Vernière we attempt to ve the existence of the poison in the arterial blood, or in the eral blood of the body, our efforts will fail completely. If, example, the carotid and jugular vein of one dog be divided, d both ends of each reciprocally connected by proper tubes ith the divided ends of the carotid and jugular of another dog, d extract of nux vomica be introduced into a wound of the ce or neck of one of them, this animal will perish in the usual me, while the other will remain unharmed to the last. This ell devised experiment, which is related by *Mr Morgan* and *Dr Addison* in their conjuct inquiry on the action of poisons*, appears to prove that the poison is not carried with the blood to the organ which is acted on; although the above-mentioned experiment of Vernière also clearly shows that the poison really enters the veins where it is immediately applied.—The same reply may be given to the famous experiment of Magendie on the effect of the extract of nux vomica, when the part where it has been applied communicates with the body only by means of two tubes which join together the divided ends of an artery and a vein. The experiment proves that the poison enters the blood and in substance reaches the trunk; but it proves no more.—As to the experiment of *Emmert* it is sufficient to reply, that the maintenance of the circulation is essential to the right discharge of all the functions, and among the rest to the integrity of all the acknowledged functions of the nerves; consequently the non-action of a poison, when a ligature is applied on the vessel which supplies the part where the poison lies, is no proof that the poison acts through the blood.—The argument which is drawn from the activity of many poisons corresponding with the absorbing power of the textures to which they are applied, has not been touched on by the supporters of action by sympathy, but will presently be seen to harmonize with that doctrine according to its newest modification.

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* Diss. Inaug. de Venenatis acidi Borussici effectibus. Tubingæ, 1805.

† Archiv für Anatomie und Physiologie, iv. 192.

‡ Journal des Progrès des Sciences Méd. 1827, iii. 121.

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* On the operation of poisonous agents on the living body, pp. 81, 87.

Besides the negative arguments thus directed against the action of poisons through absorption, several positive facts of much weight have lately been brought forward to disprove it. One of these has indeed been already stated. It is the experiment of *Mr Morgan* and *Dr Addison;* by which it appears to be proved, that the arterial blood of an animal under the influence of poison is not poisonous. Certain ingenious objections have been stated against the conclusiveness of this experiment in a late review of their treatise [*]; but if the experiment be carefully performed, so that the circulation through the connected vessels is fully maintained, I am still inclined to think that a negative result would be a strong argument in favour of their particular views.—The same experimentalists have also shown that if a poison be introduced into a great vein, with certain precautions for preventing its passage towards the heart, it nevertheless will act with unimpaired rapidity. Thus, if the jugular vein of a dog be secured by two temporary ligatures,—be divided between them,—and then reconnected by a tube which contains woorara, we find of course, on removing both ligatures, that the poison quickly begins to act. But it will act with the same quickness if we remove only the ligature farthest from the heart [†]; which is incompatible with the notion that it must be carried with the blood to the brain, the organ that is affected by it,—unless indeed it be supposed that the blood behind the ligature is carried backwards till it meet with an anastomosing vein, which does not appear probable.—They have farther shown that the operation of poisons which are believed to act through the blood, is not accelerated by introducing them into the artery which supplies the organ acted on [‡]. If the counterpart of the former of the two preceding experiments be performed on the carotid artery instead of the jugular vein, the woorara does not act more rapidly, as we should anticipate, did this poison act through the blood: and, what is still more to the point, its action on the brain and spine is not retarded when the poison is introduced in the same way into the femoral artery. On the contrary, in all the three situations, in the carotid artery, jugular vein, and femoral artery, it acts with the

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[*] London Medical and Physical Journal, lxiv. 149.

[†] Essay on Poisonous Agents, pp. 69, 71.

[‡] Ibidem, pp. 75, 76.

ickness; which is inconceivable if it acted on the brain
the blood, since in the first situation it passes instantly
t organ, and in the last it finishes its course only af-
sing through the whole systemic and pulmonary circu-

these contradictory facts are at once reconciled by the
which *Mr Morgan* and *Dr Addison* have founded on
researches, and which may be considered as the most mo-
and perfect modification of the doctrine of action through
athy. They conceive that the sympathetic action of some
ns is unequivocally established by the great rapidity of their
ts.

Such being the case, and as it is contrary to an esta-
ed law of nature to accomplish the same end in the animal
omy by two different means, it appears to them irrational
uppose that other poisons, which cause precisely the same
analogous symptoms, operate by being conveyed with the
od to the organs that suffer. In order to explain the con-
uance of the action of poisons when, as in Magendie's expe-
ent, the part directly poisoned communicates with the trunk
blood-vessels only, or when, as in their own experiment, the
ison is introduced into a vein, but prevented from reaching
e heart,—they suppose, that, like the other membranous ca-
ities of the body, the inner surface of the vascular system is
upplied with an expansion of nervous filaments, on which poi-
ons produce their peculiar impressions, and from which these
mpressions are communicated along the nerves to remote organs. In order, however, to account also for the correspondence observed between the activity of poisons and the activity of absorption in the several textures to which they are applied, it would be further necessary to maintain, that the nervous expansion of the inner membrane of the blood-vessels is more peculiarly fitted, than the sentient extremities of the nerves elsewhere, for receiving the impressions made by poisonous agents;—nay, perhaps, that it is the only nervous expansion which possesses that function, except in regard to poisons which cause evident organic injury, such as inflammation or corrosion. This important doctrine is one towards which Mr Morgan and Dr Addison evidently lean, although they have not in their work adopted it explicitly.

At all events, however, it is plain that neither the theory of these experimentalists, nor the modification of it now laid down, nor the valuable facts on which both are founded, contradict the general principle that the bibulous veins, as the organs of absorption, perform a very material part in the operation of poisons. It remains indisputably established, that at least many poisons enter the blood although doubts exist whether it is essential to their actión that they pass with the blood to pervade the structure of the organ acted on.

Of the discovery of Poisons in the Blood. With so many unequivocal proofs before us of the entrance of poisons into the blood, it becomes an object of paramount interest, with reference both to physiology and to the practice of medical jurisprudence, to inquire whether poisons can be detected in the circulating fluids, or generally in parts of the body remote from the place of their introduction.

Certain poisons, after being swallowed, have been detected in the blood and soft parts of the body, as well as in the secretions and excretions. *M. Grognier* of the Veterinary School at Lyons found sal ammoniac in the serum of horses poisoned with it[*]. In similar circumstances *Gmelin* and *Tiedemann* discovered verdigris and sugar of lead in the blood of the veins[†], and more recently *Wibmer* detected copper in the liver, and lead in the liver, spinal chord, and muscles[‡]. *Lebküchner* also found camphor in the blood of the vena cava[§]. In animals poisoned with the hydrocyanate of potass *Mayer* detected that substance not only in the blood, but likewise in the serous secretions and in various soft solids[||]. *Westrumb* detected sulpho-cyanic acid in the blood and various soft parts of dogs poisoned with sulpho-cyanate of potass[¶]. *Cantu* detected iodine, in the form of hydriodate, in the blood, sweat, urine, saliva and milk of patients who were using it medicinally[**]; *Bennerscheidt* has likewise found it in the crassamentum of the blood of a person who had been applying it externally in the form of an ointment [*]; and *Dr O'Shaughnessey* has detected it in the saliva and urine of animals killed by it given internally [†]. *Jourda* [‡], *Buchner* [§], and others have discovered mercury in the urine of persons who were taking it medicinally; and *Schubarth* has also found it in the blood of animals brought under its influence [||]. *Krimer* has detected hydrocyanic acid in the blood of animals poisoned with it [¶]. *Chaussier* detected sulphuretted hydrogen in the cellular tissue of animals killed by this gas applied externally [**]. *Rapp* in animals killed by carbazotic acid was able to trace it by its intense yellow colour in many of the membranes and secretions of the body [††]. The spirituous odour of the breath in men or animals under the influence of alcohol is a proof of the presence of that poison throughout the blood; and it is also said to have been discovered after death by the smell in the blood of the heart and even in the brain [‡‡].

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[*] *Corvisart's* Journal de Médecine, xix. 155.

[†] Nouveau Journal de Médecine, x. 469.

[‡] See the Chapters on Copper and Lead.

[§] Diss. Inaug. utrum per viventium adhuc animalium membranas materiæ ponderabiles permeare queant. Tubingæ, 1819, p. 9.

[||] Archiv für Anatomie und Physiologie, iii. 485, vi. 37.

[¶] *Ibidem*, vii. 544.

[**] Journal de Chimie Médicale, ii. 291.

Nevertheless, the more general rule certainly is that poisons, which appear to enter the blood, cannot be detected either in that fluid or in the animal solids. This may be owing to several causes.—The quantity which enters the blood-vessels may be too small to be detected after being distributed throughout the body. Thus a grain of corrosive sublimate will kill a middle-sized dog, a third of a grain of strychnia I have seen kill a wild-boar, and two grains of arsenic would certainly kill a man if injected into a vein. But these proportions are so small that no chemist would undertake to discover them, even supposing the whole quantity absorbed to be collected in the blood alone, and not to be partly distributed in the other fluids and solids. The intense colour of carbazotic acid, which is perceptible in a solution containing only a millionth part, enables the physiologist readily to trace it throughout various parts of the body; but if it were colourless like arsenic or corrosive sublimate, no chemical skill could detect it.—Again the poison may be partly or wholly removed before death beyond the reach of analysis, in consequence of its having passed off with the excretions. This appears to happen in the instance of iodine, which passes off rapidly by the urine; and it obviously happens in the case of spirituous liquors, the alcohol of which passes off quickly by the breath.—Farther it is not improbable, that certain poisons are in the course of a short time removed from the blood, and concentrated in particular organs. Such at least is the conclusion to which physiologists will be led by the late experiments of *Dr Wibmer*, if they are found on repetition to be correct. For he observed, that, in animals poisoned slowly by repeated small doses of the preparations of copper, the liver was the only part of the body where the poison could be detected; and that in animals poisoned in the same manner with sugar of lead, no lead could be discovered anywhere except in the liver, the muscles, and the spinal chord.[*]—Another important consideration is, that many poisons are in all probability decomposed in the blood. This is obvious in the changes which some of them cause in the sensible properties of that fluid,—changes which imply corresponding alterations in the poisons themselves. For example, nitric oxide gas injected into the veins gives the blood a chocolate colour and takes away its power of coagulating: Sulphuretted hydrogen often renders it viscid, greenish, or brownish, and incapable of coagulating: Hydrocyanic acid sometimes makes it oily, fluid, and bluish in colour. But other poisons, particularly of the organic kingdoms, are probably decomposed in the blood, without that fluid undergoing any apparent change. A very striking proof of this is furnished by oxalic acid. *Dr Coindet* and I, in one of our experiments, injected into the femoral vein of a dog eight grains and a-half of oxalic acid, which caused death in thirty seconds. Here it was impossible that the poison could have passed off by any of the excretions; yet we could not detect even that large proportion in the blood of the iliac vein and vena cava collected immediately after death. As the blood possessed all its usual properties, we must suppose that the poison underwent decomposition in consequence of a vital process carried on within the vessels. This observation has been confirmed by some later experiments by *Dr Pommer* of Heilbronn, which will be mentioned under the head of oxalic acid.

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[*] Journal de Chimie Médicale, iv. 383.

[†] See Chapter on Iodine.

[‡] *Corvisart's* Journal de Médecine, xxvii. 244.

[§] Toxikologie, 2te Auflage, 539.

[||] Archiv für Medizinische Erfahrung, 1823. ii. 419.

[¶] Journal Complémentaire, xxviii. 37.

[**] *Sédillot's* Journal de Médecine, xv. 28.

[††] *Buchner's* Toxikologie, 373.

[‡‡] See Chapter on Alcohol.

[*] *Buchner*—Repertorium für die Pharmacie, xxxii. 309 and 337. See also this work, *Articles* Copper and Lead.

ther poisons of the organic kingdoms must be destroy-
ke manner, by a vital action of the blood or its vessels.
the whole, then, it is not difficult to account for the fre-
ailure of chemical analysis to detect throughout the body
s which have undoubtedly pervaded it. The nature of
st reason assigned, namely, the minuteness of the quan-
hich enters the blood, should induce the toxicologist to
utmost to remove one of the great difficulties in the way,
rfecting the methods of analysis.

the Organs affected by the remote action of Poisons.—Hav-
ow taken a general view of the mode in which poisons act
istant parts, I shall next consider what organs are thus
ght under their operation. Poisons are commonly, but I
eive erroneously, said to affect remotely the general sys-

A few of them, such as arsenic and mercury, do indeed
ear to affect a great number of the organs of the body. But
nuch the larger proportion seem on the contrary to act on
or more organs only, not on the general system.

)f the poisons which act remotely through a sympathy of
tant parts with an organic injury of the textures directly act-
on, many appear to act sympathetically on the heart alone.
king the mineral acids as the purest examples of poisons that
t independently of absorption into the blood-vessels, it will
seen on inquiry that all the symptoms they produce, in ad-
tion to the direct effects of the local injury, are those of de-
essed action of the heart,—great feebleness, fainting, imper-
ptible pulse, cold extremities. Even the less prominent of
e secondary symptoms are almost all referrible to a depressed
tate of the circulation. In particular, they are not necessarily,
nd indeed are seldom actually blended with any material symp-
om of disorder in the brain; which certainly could not be the
case if the general or whole system suffered.

With respect to that more numerous class which act remote-
ly either through the medium of the blood or by the transmis-
sion along the nerves of an undiscernible impression made on
their sentient extremities, some certainly possess a very extend-
ed influence over the great organs of the body; but others are
much more limited in their sphere of action.

Some poisons of this kind act chiefly, if not solely, on the

Heart. The best examples are infusion of tobacco, and upas antiar. *Mr Brodie* observed, that when the infusion of tobacco was injected into any part of the body, it speedily caused great faintness and sinking of the pulse; and on examining the body instantly after death, he found the heart distended and paralyzed, not irritable even to galvanism, and its aortal cavities filled not with black, but with florid blood, while the voluntary muscles were as irritable as after other kinds of death*. The upas antiar he found to be similarly circumstanced†; and *Geiger* has extended the same observation to the active principle found by him in hemlock‡. The same phenomena have been observed in the instance of other poisons, which, however, have also the power of acting on various organs besides the heart. Arsenic and oxalic acid are of this kind. In an animal killed by arsenic, whose heart immediately after death contained arterial blood in its aortal cavities, and was insensible to galvanism, *Dr Campbell* found the gullet contract under galvanism for twenty minutes, and the voluntary muscles even longer §. *Dr Coindet* and I frequently witnessed the same facts in animals killed with oxalic acid: When the heart at the moment of death was completely palsied and deprived of irritability, we saw the intestines moving, and the voluntary muscles contracting long and vigorously from the mere contact of the air ||.

Other poisons act on the *Lungs;* but we are not acquainted with any which act on them alone. *Magendie* found that in poisoning with tartar emetic the lungs are commonly inflamed and sometimes even hepatized¶. *M. Smith* and *M. Orfila* both remarked similar signs of pulmonary inflammation in animals poisoned with corrosive sublimate**. But these poisons produce important effects on other organs likewise.

A great number of the poisons now under consideration act

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* Philosophical Transactions, 1811, p. 186. When death begins with any other organ but the heart, the heart remains irritable for some time after, and contains black blood in all its cavities.

† Ib. p. 196.

‡ Magazin für Pharmacie, xxxv. 83.

§ Diss. Inaug. de Venenis Mineralibus. Edinburgi, 1813.

|| Edin. Med. and Surg. Journal, xix. *passim.*

¶ Mémoire sur l'Emétique—Bulletins de la Société Philomatique, 1812-13, p. 361.

** Orfila, Toxicologie Générale, i. 258.

Brain. The most decided proof of such an action is the
of the symptoms, which are convulsions, giddiness, deli-
alsy, coma. Some physiologists have also sought for evi-
in the body after death, and have imagined they found
ongestion of the vessels of the brain, and even extravasa-
f blood there; but it will be seen under the head of Nar-
Poisons that such appearances are far from being essential,
deed are seldom witnessed. All narcotic poisons act on the
, and most narcotico-acrids too; but very frequently other
ns are acted on at the same time, in particular the spine and
t.—It has been maintained by some that all poisons which
a remote action, exert it through the medium of the brain.
s is probably true of many poisons; but it does not apply well
hose which act on remote organs, such as the heart or spine,
hout causing any sensible symptom referrible to the head.
e infusion of tobacco paralyzes the heart, and nux vomica irri-
s the spine, without causing any disorder of the mind; which
ld scarcely happen if they acted through the medium of the
in. Some poisons too retain their action, although the brain
removed, as will be seen under the head of hydrocyanic
id.

Few poisons act specifically on the *Spinal Chord*. The only
ecies, indeed, which are known to possess such an action are
ux vomica, the other species of plants which, like it, contain
rychnia, and the false angustura bark. These singular sub-
tances excite violent fits of tetanus, during the intervals of
which the mind and external senses are quite entire; and death
takes place during a paroxysm, apparently from suffocation
caused by spasmodic fixing of the chest. Their action on the
spine is quite independent of any action on the brain, if indeed
such action exist at all; for when the spinal chord is separated
from the brain by dividing the medulla oblongata, the effects
on the muscles supplied by the spinal chord are produced as
usual[*].—Many poisons which act on the brain also act on the
spinal chord.

The organs not immediately necessary to life may be likewise
all acted on by poisons indirectly. On this subject details are
not called for at present. It may be sufficient to remark that

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[*] *Emmert*, Archiv für Anatomie und Physiologie, i. 1. 180. See also the *Ar-*
ticle False Angustura.

there is hardly a considerable organ in the body, except perhaps the spleen and pancreas, which is not acted on by one poison or another. Arsenic inflames the alimentary mucous membrane, mercury the salivary organs and mouth, cantharides the urinary organs, chromate of potass the conjunctiva of the eyes, manganese the liver; iodine acts on the lymphatic glands; spurred rye causes gangrene of the limbs.

Some poisons, as was already mentioned, may act on one important organ only, every other being left undisturbed: thus, nux vomica in general acts only on the spine. But much more commonly they act on several organs at once; and the action of some of them is complicated in an extreme degree. I may instance oxalic acid and arsenic. Oxalic acid when swallowed irritates and inflames the stomach directly, and acts indirectly on the brain, the spine, and the heart. A large dose causes sudden death by paralyzing the heart; if the dose is somewhat less the leading symptom is violent tetanic spasm, indicating an action on the spine, and death takes place during a paroxysm, the heart continuing to contract for some time after; if the dose is still less, the spasms, at first distinct, become by degrees fainter and fainter, while the sensibility in the intervals, at first unimpaired, becomes gradually clouded, till at length pure coma is formed without convulsions,—thus indicating an action on the brain. As for arsenic, coupling together the symptoms during life and the appearances in the dead body, we shall afterwards find that it has the power of acting on the brain, heart, and lungs,—the throat, gullet, stomach, and intestines,—the lining membrane of the nostrils and eyelids,—the kidneys, bladder, and vagina; and, what is remarkable, proofs of an action on all these parts may be witnessed in the course of a single case. The effects of mercury are hardly less multifarious.

SECTION II.—*On the Causes which modify the Actions of Poisons.*

By a variety of causes the action of poisons may be modified both in degree and in kind. The most important of them are—quantity; state of aggregation; state of chemical combination; mixture; differences in tissue; differences in organ; habit; idiosyncrasy; and lastly, certain states of disease.

1. *Quantity* affects their action materially. Not only do they produce their effects more rapidly in large doses; it is some-

times even quite altered in kind. A striking example has just been related in the case of oxalic acid; which, according to the dose, may corrode the stomach, or act on the heart, or on the spine, or on the brain. In like manner arsenic in a small dose may cause gastritis of several days' duration; while a large dose may prove fatal in two or three hours by affecting the action of the heart. White hellebore in small doses excites inflammation in the stomach and bowels, in larger doses giddiness, convulsions, coma; and in either way it may prove fatal.

2. *As to state of Aggregation,*—poisons act the more energetically the more minutely they are divided, and hence most energetically when in solution. Some which are very energetic in the fluid state, hardly act at all when undissolved. Morphia, the alkaloid of opium, may be given in powder to a dog without injury in a dose, which, if dissolved in oil or alcohol, would soon kill several. Previously dissolving poisons favours their action in two ways,—by diffusing them quickly over a large surface, and by fitting them for entering the bibulous vessels. Poisons, before being absorbed, must be dissolved; and hence, those which act though solid and insoluble in water, must, as a preliminary step, be dissolved by the animal fluids at the mouths of the vessels. In this way the poisonous effects of carbonate of baryta and arsenite of copper are explained, for though almost or entirely insoluble in water, they are soluble in the juices of the stomach.

Differences in aggregation, like differences in quantity, may affect the kind as well as the degree of action. Camphor in fragments commonly causes inflammation of the stomach; dissolved in spirit or olive oil, it causes delirium or tetanus and coma.

The reduction of certain poisons to the state of vapour serves the same end as dissolving them. When poisons are to be introduced by the skin, no previous operation is more effectual than that of reducing them to vapour.

3. The next modifying cause is *Chemical combination.* This is sometimes nothing more than a variety of the last. If the substance with which a poison is combined increases its solubility, it generally increases its activity, and *vice versa:* Morphia, itself almost inert, because insoluble, becomes active by uniting with acids, for they render it very soluble: Baryta, a

very active poison, becomes quite inert by uniting with sulphuric acid, for the sulphate of baryta is quite insoluble.

In regard to the influence of chemical combination two general laws may be laid down. One is, that *poisons which only act locally, have their action much impaired or even neutralized, in their chemical combinations.* Sulphuric acid and muriatic acid on the one hand, and the two fixed alkalis on the other, possess a violent local action; but if they are united so as to form sulphates or muriates, although still very soluble, they become merely gentle laxatives. But the case is altered if either of the combining poisons also act by entering the blood. For the second general law is, that *the action of poisons which operate by entering the blood, although it may be somewhat lessened, cannot be destroyed or altered in their chemical combinations.* Morphia acts like opium if dissolved in alcohol or fixed oil; if an acid be substituted as the solvent, a salt is formed which is endowed with the same properties: The sulphate, muriate, nitrate, acetate of morphia all act like opium. Strychnia, arsenic, hydrocyanic acid, oxalic acid, and many more come under the same denomination: Each produces its peculiar effects, with whatever substance it is combined, provided it do not by undergoing combination become insoluble.

4. The effect of *Mixture* depends partly on the poisons being diluted. Dilution, by prolonging the time necessary for their being absorbed, commonly lessens their activity; yet not always; for if a poison which acts through the blood is also a powerful irritant, moderate dilution will enable it to enter the vessels more easily: A small dose of concentrated oxalic acid acts feebly as an irritant or corrosive; moderately diluted, it quickly enters the blood and causes speedy death*.—The effect of mixture may depend also in part on the mere mechanical impediment thrown between the poison and the animal membranes. This is particularly obvious when the mass containing the poison is solid or pulpy; for then the first portions of the poison that touch the membrane may cause an effort of the organ to discharge the rest beyond the sphere of action—if, for example, it is the stomach,—by vomiting. The effect of mixture in interposing a mechanical impediment is also well illustrated where the substance mixed with the poison is a fine, insoluble powder,

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* Edin. Med. and Surg. Journal, xix. 326, 327.

e of enveloping its several particles. Thus it is that small, isonous doses of arsenic may be often swallowed and re- with impunity, if mixed with finely powdered charcoal, esia, and probably cinchona-bark, or the like.—Besides di- and mechanically obstructing their application, the ad- re of other substances may alter the chemical nature of ns, and so change their action.

is important to keep in view that the influence of mixture be exerted in consequence of the cavity into which even re poison is introduced being at the time filled with con- s. Some of the most powerful and unerring poisons may uch circumstances altogether fail to produce their usual ef- if speedily vomited. Thus *Wibmer* notices the case of a n, who swallowed an ounce and a-half of arsenic after a very rty meal, had merely a severe attack of vomiting with sub- uent colic, and got quite well in four days *. And a still re pointed instance has been briefly mentioned by *Dr Booth* Birmingham, where an ounce of corrosive sublimate was allowed after a full meal without any material ill consequence, miting having been speedily induced †.

5. *Difference of Tissue* is an interesting modifying power in physiological point of view, but does not bear so directly on edico-legal practice as the rest, and may therefore be passed ver cursorily.

On the corrosives and irritants a difference of tissue acts but indirectly: Their effects vary not so much with the tissue as with the organ of which it forms part. But as to poisons which act through the blood or on the inner coat of the blood-vessels, their energy must evidently depend on the activity of absorption in each texture.

The cutaneous absorption is slow, on account of the obstacle presented by the cuticle, and by the intricate capillaries of the true skin. Accordingly many active poisons are quite inert when applied to the unbroken skin, or even to the skin deprived of the cuticle. Hydrocyanic acid, perhaps the most subtile of all poisons, was found by *Coullon* to have no effect when dropped on the skin of a dog ‡. Some authors have even gone so far as to deny that poisons can be absorbed at all through the skin, unless they are pressed by friction through the cuticle. But this is an error; most gaseous poisons, such as carbonic acid and sulphuretted hydrogen, and some solid poisons when volatilized, such as the vapours of cinnabar, will act though simply placed in contact with the skin; and there is distinct evidence that corrosive sublimate will bring on mercurial action in the form of warm bath.

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* Die Wirkung der Arzneimittel und Gifte, i. 278.

† London Medical Gazette, xiv. 63.

‡ Recherches sur l'Acide Hydrocyanique, 140.

On the Mucous membrane of the stomach and intestines, poisons act much more energetically than on the skin; which clearly depends in a great measure on the superior rapidity of absorption there, and perhaps also on the facility with which poisons come in contact with the sentient extremities of nerves.

The Serous membranes possess an activity of absorption which hardly any other unbroken texture can equal. Accordingly many poisons act much more rapidly through the peritonæum than through the stomach: When oxalic acid is introduced under the same collateral circumstances into the stomach of one dog and the peritonæum of another, the dose may be so apportioned, that the same quantity, which does not prove fatal to the former, kills the latter in fourteen minutes *.

While the preceding modes in which poisons enter the blood are indirect, they may be introduced directly by a Wound in a Vein. There is no way in which poisons, that act through the blood, prove more rapidly fatal. Some which act very slowly through the stomach cause instant death when injected into a vein.—A peculiar variety of this mode of introducing poisons deserves to be distinguished, namely, the application of them to a wound. If the surface bleeds freely, they may not act at all, because they are washed away. But if they adhere, they soon enter the divided veins. Hence, if they act in small doses, this mode of applying them is hardly less direct than if they were at once injected into a vein.

So far the effect of difference in tissue has been determined. Poisons that act through the blood act least energetically on the skin, more actively on the alimentary mucous membrane, still more so on serous membranes, and most powerfully of all when introduced directly into a vessel. There are other tex-

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* Edin. Med. and Surg. Journal, xix. 330.

tures, however, which merit notice, although their place in the scale of activity has not been exactly settled.

On the Mucous membrane of the Pulmonary air-cells and tubes, poisons act with a rapidity which is not surpassed by their direct introduction into a vein. This is plainly owing to the exceeding delicacy and wide surface of the membrane. Hence three or four inspirations of carbonic oxide gas will cause instant coma. A single inspiration of the noxious gas of privies has caused instant extinction of sense and motion. Nay, liquid poisons have been known to act through the same channel with almost equal swiftness. For *M. Ségalas* found that a solution of extract of nux vomica caused death in a few seconds when injected in sufficient quantity into the windpipe; and that half a grain will thus kill a dog in two minutes, while two grains will rarely prove fatal when injected into the stomach, peritonæum, or chest [*].

As to the nervous tissue, it is a singular fact, and well worthy of mention, that the poisons which appear to act on the sentient extremities of the nerves, and indirectly through the nerves on the brain and spine,—do not act at all on the cut surface of the brain and nerves, or upon any part of the course of the latter. This has been proved with respect to hydrocyanic acid, opium, strychnia, and all active narcotics.

The power of the Cellular tissue as a medium of absorption, has not been, and cannot easily be, ascertained. On the one hand it is difficult to apply poisons to it, without also applying them to the mouths of divided vessels; and, on the other hand, it is difficult to make a set of experiments for comparison with others on the stomach, pleura, or peritonæum, as the cellular tissue does not form an expanded membrane, and consequently, the extent of surface to which a poison is applied cannot be made the same in each experiment of a series.

The variations caused by difference of tissue in the activity of poisons have been viewed in the previous remarks as depending chiefly on the relative quickness with which absorption goes on. But in this way it is impossible to explain the whole amount of the differences sometimes observed. Some poisons cause death when applied to a wound in the minutest quantity, but are quite harmless when swallowed in large doses: Others are diminished a little in activity, but still remain powerful and fatal poisons. There is not much difference in the power of arsenic when it is applied to different textures, the skin excepted. But oxalic acid injected into the peritonæum will act eight or ten times more rapidly than when swallowed; and the poison of the viper may prove fatal to man through a wound in almost invisible doses, while the whole poison of six vipers may be swallowed by so small a creature as a blackbird, with complete impunity [*]. Differences in the absorbing power of the tissues cannot explain these facts.

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[*] Journal de Physiologie, iv. 285.

The only rational way of accounting for them is by supposing that a part of the poison is decomposed,—the change being greatest where absorption is slowest and the power of assimilation strongest, namely, in the stomach,—and least where absorption is quickest and assimilation almost wanting, namely, in a wound. This explanation derives support from the different effects of change of tissue on poisons of the different kingdoms. Mineral poisons are least, and animal poisons are most, affected in their action by differences of tissue, while vegetable poisons hold the middle place:—an arrangement which coincides with the respective difficulty of decomposition among mineral, vegetable, and animal substances generally, whether under physical or under vital processes [†].

6. With respect to differences arising from *Difference of Organ*, these will, of course, be partly attributable to differences in tissue, but not altogether. For example, in the case of the pure corrosives or irritants, the injury caused will depend for its danger on the importance of the organ to the general economy of the body: Inflammation caused by a local poison in the stomach will be more quickly fatal than that excited in the intestines only; and such a poison may act violently on the external parts without materially impairing the general health.

7. *Habit and Idiosyncrasy*. The remarks to be made under the present head are important in a medico-legal point of view; for they show how one man may be poisoned by a substance

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[*] Giornale di Fisica, ix. 458.

[†] These views regarding the decomposition of poisons, were suggested to me some years ago by my friend Dr Coindet *Junior* of Geneva, who promised to make them the subject of future experiments, but has not yet, so far as I know, accomplished his purpose.

harmless, and another not harmed by a substance oisonous.

endency of *Idiosyncrasy* is generally to increase the of poisons or even to render some substances deletehich are commonly harmless.

effect of opium in medicinal doses is commonly pleasant utary; but in some individuals it produces disagreeable en dangerous effects. Mercury, which in moderate doses the most part a mild laxative or sialagogue, will cause in people, even in the dose of a few grains, violent salivation, ation of the mouth, nay fatal gangrene.—On the other , a few substances, which to most people are actively poisonhave on some individuals comparatively little effect. There extremely few poisons, however, in regard to which this l of idiosyncrasy is well-established and prominent. Mery and alcohol are examples. Mercury, which in moderate ntity, as already observed, is a mild laxative or sialagogue most people, and to some persons is a dangerous poison in ry small doses, would, on the contrary, appear in other contutions to be extremely inactive: for it has occasionally been und impossible to bring on the peculiar constitutional action f mercury by continuing the use of its preparations for months ogether. In general children are not easily affected by it as a ialagogue, but easily by its laxative action. As to alcohol, it is a familiar fact, that independently of the effects of habit, there are some constitutions which cannot be brought under the influence of intoxicating liquors without an extraordinary quantity of them and a long-continued debauch, while others are overpowered in a short space of time, and by very moderate excess; and there is no reason to doubt that very great constitutional differences also prevail in regard to the operation of a single large dose.

But not only does idiosyncrasy modify the action of poisons; through its means, too, some substances are actually poisonous to certain individuals, which to mankind in general are unhurtful, nay even nutritive.

With some people all kinds of red fish, trout, salmon, and even the richer white fish, herring, mackarel, turbot, or holibut, disagree, as it is called—that is, act after the manner of poisons: They produce fainting, sickness, pain of the stomach; and if they were not speedily evacuated by vomiting, dangerous consequences might ensue. The same is often the case with mushrooms. The esculent mushrooms act on some people nearly in the same way as the poisonous varieties. Bitter almonds and other vegetable substances that contain hydrocyanic acid, sometimes produce stupor or nettle-rash in the small quantities used for seasoning food.

This idiosyncrasy may even be acquired. One of my relations, who was for many years violently affected by very small quantities of the richer kinds of fish, used at a previous period to eat them, and can now again do so, with impunity. Many people have acquired a similar idiosyncrasy with respect to eggs; instances of the same kind will be afterwards mentioned in respect to shell-fish, particularly muscles; indeed there are probably few articles of food in regard to which such idiosyncrasies may not in a few rare instances be met with, if we except the grains and common kinds of butcher-meat. I may add, that from facts which have come under my notice, I have sometimes suspected that a similar idiosyncrasy may be acquired in a slight degree, and for a short time only, in regard even to some kinds of butcher-meat, especially the flesh of young animals.

It does not appear well ascertained, that the effect of idiosyncrasy is ever to impair materially the energy of poisons, except in the instances of mercury and alcohol.

On the contrary, the tendency of *Habit* when it does affect their energy, is, with a few exceptions, to lessen it. By the force of habit a person may take without immediate harm such enormous quantities of some poisons as would infallibly kill an unpractised person or himself when he began. There have been opium-eaters in this country who took for days together ten ounces of laudanum daily.

The precise influence of habit has been ascertained in the case of a few common poisons only. On the whole, it would appear that more change is effected by habit on the action of the organic than on that of the inorganic poisons; and that of the former, those which act on the brain and nervous system, and produce *narcotism*, are altered in the most eminent degree. The best examples of the influence of habit are opium and vinous spirits. The action of such poisons is not always, however, entirely thrown away; they still produce some immediate effect; and farther, by being frequently taken, they may slowly bring on certain diseases, or engender a predisposition to disease. A very singular exception to this rule prevails in the instance of tobacco, which, under the influence of habit, may be smoked daily to a considerable amount, and so far as appears without any cumulative effect on the constitution, like that of opium-eating or drinking spirits.

The inorganic poisons are most of them little impaired in activity by the force of habit. The pure irritants, indeed, do lose a little of their energy; for it seems that persons have acquired the power of swallowing with impunity considerable doses of the mineral acids. But as to inorganic poisons that enter the blood, habit certainly does not diminish, probably rather increases, their power. There is no satisfactory evidence, that a person by taking gradually-increasing doses of arsenic may acquire the power of enduring a considerably larger dose than when he began: On the contrary, the stomach rather becomes more tender to the subsequent dose by each repetition. I have little hesitation in avowing my disbelief of the alleged cases of arsenic-eaters and corrosive-sublimate-eaters, who could swallow whole drachms at once with impunity.

In the relative influence of habit on poisons of the three kingdoms of nature, a new argument will be discovered for the opinion given above respecting the partial decomposition of organic poisons in some of the tissues. In fact this partial decomposition accounts very well for the effect of habit: The effect of habit is nothing more than an increased power acquired by the stomach of decomposing the poison,—just as it gradually acquires an increased facility in digesting some alimentary substances which are at first very indigestible.

8. The last modifying cause to be mentioned comprehends certain *Diseased states of the Body*. The effect of disease, like that of habit, is in general to impair the activity of poisons. But it is only in the instance of a few diseases that this diminution is so strongly marked as to be important in relation to medical jurisprudence.—In the continued fever of this country there is a diminished susceptibility of the constitutional action of mercury; and this peculiarity is very strongly marked in the yellow fever, as well as in the bilious fevers generally of tropical climates. In some varieties of typhoid fever there is obviously a diminished sensibility to the action of wine and other spirituous liquors; but this diminution in a great majority of cases is much inferior to what some physicians have represented.—In severe

dysentery the susceptibility of the narcotic action of opium is so much impaired, that a person unaccustomed to the use of that drug, may continue to take daily, for several days together, a quantity which might prove fatal to him in a state of health. In the severe form which dysentery occasionally puts on in this country I have known a patient take from twenty-four to thirty grains of opium daily, and retain it all, without experiencing more than a mild narcotic action.—In epidemic cholera the same insensibility has been remarked to the operation of opium.—It also occurs in the instance of excessive hemorrhagy.—There is no disease, however, in which the power of mitigating the action of poisons is more remarkably exhibited, than in tetanus: It is often scarcely possible to bring on the narcotic action of opium by any doses which can be exhibited; calomel, too, acts with much less energy than usual; and even common purgatives must be administered in doses considerably larger than those required in most other disorders.—Mania is similarly circumstanced: almost all remedies must be given in increased doses, narcotic remedies in particular. But there is good reason for believing that the impaired susceptibility of the action of poisons remarked in this disorder is far from being always so great as some have alleged.—Another disease allied to the last, where the diminution of susceptibility is often very great, is delirium tremens. It has in particular been often found, that to produce sleep in this disease opium must be given in very large doses,—so large indeed, that they would undoubtedly prove fatal to a person in health. At the same time it is worthy of remark, that in some cases of delirium tremens, even violent in degree, the peculiarity now specified, as I have myself several times witnessed, is far from being strongly marked.—Hydrophobia always, and Hysteria sometimes, impair the activity of poisons. I have seen cases of hysteria, more particularly those assuming the form of tetanus, where very large doses of opium were required to produce a calmative effect and sleep; and in hydrophobia it is well shown that the narcotic action of opium is not produced even by large doses often repeated.

In the operation of this class of modifying agents it is a general law, to which there are probably few exceptions, that they affect chiefly the poisons of the organic kingdoms, and above all the narcotics. At least in the instance of most mineral poisons its influence is very inferior. Its operation may be accounted for in various ways. Sometimes, as in dysentery and cholera, the poison is carried with unusual rapidity through the alimentary canal. Sometimes again it remains comparatively inert, because on account of the impaired activity of absorption, it is not taken up with the usual quickness by the absorbent vessels. And sometimes, as in the instance of tetanus, mania, and rabies, the nervous system is in a state of peculiar excitement, by which the customary action of the poison is in a great measure, if not entirely, counteracted.

In a few diseased states of the system there is an increased susceptibility of the action of poisons; and it is important that the medical jurist should attend to this circumstance. When a poison has a tendeney to bring on a peculiar pathological state of the system or of a particular organ, which is also produced by a disease existing at the time or impending, violent and even fatal consequences may ensue from doses of poisons which in ordinary circumstances are innocuous or beneficial. Thus in persons affected with apoplexy an ordinary dose of opium may accelerate death; and in people even with a mere tendency to apoplexy, if it is strongly marked, or appears from what are called warning symptoms to be on the point of developing itself, a common dose of such narcotics as occasion determination to the brain may excite the apopletic attack. Thus, too, in cases of inflammatory disorders of the alimentary canal, irritating substances, in doses not otherwise injurious, may produce dangerous impressions on the tender membrane with which they come in contact. But in respect to this last example, it must be remarked, that the improvements or the caprice of medical practice have gone directly in face of the rule, by suggesting that some internal inflammations of the alimentary canal may be successfully treated with irritating remedies.

I might here perhaps have added among the causes which modify the action of poisons, Sleep, and the Administration of other Poisons. The latter subject, however, will be better considered at the end of the Individual Poisons, under the title of Compound Poisoning. The former agent is of doubtful effect. Some observations on its influence will be found in the chapter on the Evidence of General Poisoning, p. 44.

Application of the preceding remarks to the Treatment of Poisoning. As an appendix to what has been said respecting the physiological action of poisons, and the causes by which it is liable to be modified, I shall here state shortly certain applications to the treatment of poisoning.

In the instance of internal poisoning, the great object of the physician is to administer an antidote or counterpoison. Antidotes are of two kinds. One kind takes away the deleterious qualities of the poison before it comes within its sphere of action, by altering its chemical nature. The other controls its poisonous action after it has begun, by exciting a contrary action in the system. In the early ages of medicine almost all antidotes were believed to be of the latter description, but in fact very few antidotes of the kind are known.

The chemical antidotes operate in several ways, according to the mode of action of the poison for which they are given. If the poison is a pure corrosive, such as a mineral acid, it will be sufficient that the antidote destroy its corrosive quality: Thus the addition of an alkali or earth will neutralize sulphuric acid, and destroy or at least prodigiously lessen its poisonous properties. In applying this rule care must be taken to choose an antidote which is either inert, or, if poisonous, is, like the poison for which it is given, a pure corrosive or local irritant, and one whose properties are reciprocally neutralized.

If the poison, on the other hand, besides possessing a local action, likewise acts remotely through absorption, or by an impression on the inner coat of the vessels, mere neutralization of its chemical properties is not sufficient; for we have seen above that such poisons act throughout all their chemical combinations which are soluble. Here, therefore, it is necessary that the chemical antidote render the poison insoluble or nearly so; and insoluble not only in water, but likewise in the animal fluids, more particularly the juices of the stomach. The same quality is desirable even in the antidotes for the pure corrosives; for it often happens that in their soluble combinations these substances retain some irritating, though not any corrosive power. When we try by the foregoing criterions many of the antidotes which have been proposed for various poisons, they will be found defective, as precise experiments have in recent times actually proved them to be.

The other kind of antidote operates not by altering the form of the poison, but by exciting in the system an action contrary to that established by the poison. On considering attentively, however, the phenomena of the action of individual poisons, it will be found exceedingly difficult to say what is the essence of a contrary action, and still more how that counter action is to be brought about. Accordingly, few antidotes of the kind are known. Physiology or experience has not yet brought to light any mode of inducing an action counter to that caused by arsenic and most of the irritant class of poisons. It appears probable that the remote operation of lead may be sometimes corrected by mercury given to salivation, and that the violent salivation caused by mercury may be occasionally corrected by nauseating doses of antimony. But these are the only instances which occur to me at present of antidotes for irritant poisoning which operate by counter action, unless we choose to designate by the name of antidote the conjunction of remedial means which constitute the antiphlogistic method of cure. In the class of narcotics we are acquainted with equally few constitutional antidotes, although the nature of the action of these poisons seems better to admit of them. Ammonia is to a certain extent an antidote for hydrocyanic acid, but by no means so powerful as some persons believe; and I am not sure that in this class of poisons we can with any propriety mention another antidote of the constitutional kind.

On the whole, then, it is chiefly among the changes induced by chemical affinities that the practitioner must look for counter-poisons; and the ingenuity of the toxicologist has thence supplied the materia medica with many of singular efficacy. When given in time, magnesia or chalk is a complete antidote for the mineral acids and oxalic acid, albumen for corrosive sublimate and verdigris, bark for tartar emetic, common salt for lunar caustic, sulphate of soda or magnesia for sugar of lead and muriate of baryta, chloride of lime or soda for liver of sulphur, vinegar or oil for the fixed alkalis; and these substances act either by neutralizing the corrosive power of the poison, or by forming with it an insoluble compound.

In the instance of external poisoning the main object of the practitioner is to prevent the poison from entering the blood, or to remove it from the local vessels which it has entered.

One mode, which has been known to the profession from early times, and after being long in disuse was lately revived by *Dr Barry*, and applied with success to man, is the application of cupping glasses to the part where the poison has been introduced*. This method may act in various ways. It certainly prevents the farther absorption of the poison by suspending for a time the absorbing power of the vessels of the part covered by the cup. It also sucks the blood out of the wound, and consequently washes the poison away with it. But possibly it likewise compresses the nerves around, and prevents the impression made by the poison on their sentient extremities from being transmitted along their filaments.

Another mode is by the application of a ligature between the injured part and the trunk so as to check the circulation. This is a very ancient practice in the case of poisoned wounds, and is known even to savages. But as usually practised it is only a temporary cure. As soon as the ligature is removed the effects of the poison begin. It may be employed, however, for many kinds of poisoning through wounds, so as to effect a radical cure. We have seen that most poisons of the organic kingdom are in no long time either thrown off by the system or decomposed in the blood; hence if the quantity given has not been too large, recovery will take place. Now, by means of a ligature, which is removed for a short time at moderately distant intervals, a poison, which has been introduced into a wound beyond the reach of extraction, may be gradually admitted into the system in successive quantities, each too small to cause death or serious mischief, and be thus in the end entirely removed and destroyed. Such is a practical application which may be made of some ingenious experiments performed not long ago by *M. Bouillaud* with strychnia, the poisonous principle of nux vomica†.

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* It is not any part of the object of this work to enter into the history of toxicology, more especially in early times. But it may be well here to state, that the claim which has been made by some for Dr Barry, of having discovered this mode of treatment, is groundless. It is distinctly laid down by Nicander, Celsus, Dioscorides, Galen, and others who lived in their times; and among the moderns who have mentioned it, *Gräter* in 1767 notices it in his thesis, " de venenis in genere" printed at Frankfort. On the ancient history of toxicology the reader will find an excellent summary by *Mr Adams* in the Edinburgh Medical and Surgical Journal, xxxiii. 315, and a full exposition in *Professor Marx's* elaborate work, " die Lehre von den Giften."

† Archives Générales de Médecine, Nov. 1826.

The last mode to be mentioned is by a combination of the ligature with venesection, deduced by *M. Vernière* from his experimental researches formerly noticed, (p. 10.) Suppose a fatal dose of extract of nux vomica has been thrust into the paw of a dog; M. Vernière applies a tight ligature round the limb, next injects slowly as much warm water into the jugular vein as the animal can safely bear, and then slackens the ligature. The state of venous *plethora* thus induced completely suspends absorption. The ligature is next tied so as to compress the veins without compressing the arteries of the limb, and a vein is opened between the wound and the ligature in such a situation, that the blood which flows out must previously pass through, or at least near, the poisoned wound. When a moderate quantity has been withdrawn, the ligature may be removed with safety; and the extraction of the poison may be farther proved by the blood that has been drawn being injected into the veins of another animal; for rapid death by tetanus will be the result *. It is not improbable that in this plan the preliminary production of venous plethora may be dispensed with; and then the treatment may be easily and safely applied to the human subject.

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* Journal des Progrès des Sciences Médicales, 1827, iii. 121.

CHAPTER II.

ON THE EVIDENCE OF GENERAL POISONING.

This subject is purely medico-legal. It comprehends an account of the various kinds of evidence by which the medical jurist is enabled to pronounce whether poisoning in a general sense, (that is, without reference to a particular poison,) is impossible, improbable, possible, probable, or certain. It likewise comprises an appreciation of the circumstances which usually lead the unprofessional, as well as the professional, to infer correctly or erroneously a suspicion of such poisoning.

Under the present head might likewise be included the history of poisoning, the art of secret poisoning, and some other topics of the like kind. But the want of proper documents, and the unmeasured credulity which has prevailed on the subject of poisoning throughout all ages down to very recent times, has entangled these subjects in so intricate a maze of fable, that a notice of them, sufficiently detailed to interest the reader, would be quite misplaced in this work.

On the Art of Secret poisoning, however, as having been once an important object of Medical Jurisprudence, it might be expected that some comments should here be offered. But really I do not see any good reason for wading through the mass of credulous conjectures and questionable facts, which have been collected on the subject, and which have been copied into one modern work after another, for no other cause than that they are of classic origin, or feed our appetite for the mysterious. No one now seriously believes that Henry the Sixth was killed by a pair of poisoned gloves, or Pope Clement the Seventh by a poisoned torch carried before him in a procession, or Hercules by a poisoned robe, or that the operation of poisons can be so predetermined, as to commence or prove fatal on a fixed day, and after the lapse of a definite and remote interval. With regard to the noted instances of secret poisoning, which occurred towards the close of the seventeenth century in Italy and France, it is plain to every modern toxicologist, from the only certain knowledge handed down to us of these events, that the actors in them owed their success rather to the ignorance of the age, than to their own dexterity. And as to the refined secrets believed to have been possessed by them, it is sufficient here to say, that although we are now acquainted with ten times as many and ten times as subtile poisons as were known in those days, yet none exist which are endowed with the hidden qualities once so universally dreaded.

The crime of poisoning, from its nature, must always be a secret one. But little apprehension need be entertained of the Art of secret poisoning as understood by Toffana or Brinvilliers*, or as it might be improved by a modern imitator. It seems to have escaped the attention of those who have written on the subject, that the practice of such an art requires the knowledge not only of a dexterous toxicologist, but also of a skilful physician; for success must depend on the exact imitation of some natural disease. It is only among medical men, therefore, and among the higher orders of them, that a Saint-Croix can arise now a-days. How little is to be dreaded on that head is apparent from the domestic history of the European kingdoms for the last half century, compared with their history some centuries ago. Few medical men have even been suspected, and those few only upon visionary grounds, and under the impulse of violent political feeling†. In one late instance only, so far as I am aware, has it been proved that the physician's art was actually prostituted to so fearful a purpose; and the detection of the crime in that instance shows how difficult concealment will always be wherever justice is administered vigorously, and medico-legal investigations skilfully conducted‡.

Two extraordinary incidents which happened lately in Germany may appear at first sight at variance with these views. I allude to the cases of Anna Margaretha Zwanziger and Margaretha Gottfried, which justly excited much interest where they occurred, and are notorious to continental toxicologists. Zwanziger, while serving as housekeeper in various families in the territory of Bayreuth in Bavaria during the years 1808 and

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* See the Chapter on Arsenic for some remarks on this subject.—Also *Beckman's* History of Inventions.

† See subsequently the cases of the Crown Prince of Sweden, in the first *Section* of the present chapter, and that of General Hoche, Part II. Chap. ii. Sect. 2.

‡ I allude to the case of Castaing. See Opium.

1809, contrived to administer poison,—sometimes under the instigation of mere revenge or spite, sometimes for the purpose of clearing the way for her schemes of marriage with her masters,—to no fewer than seventeen individuals in the course of nine months; and of these three died *. Gottfried, a woman in affluent circumstances and tolerable station in the town of Bremen, was even more successful. For she pursued her criminal career undiscovered for fifteen years; and when dectected in 1828 had murdered actually fourteen persons, and administered poison unsuccessfully to several others. Her motive, as in the case of Zwanziger, was the mere gratification of a malevolent temper, or the removal of supposed obstacles to her matrimonial dreams. In neither of these instances, however, did the criminal possess any particular skill, or observe much measure in her proceedings. The cases of poisoning were of the common kind,—produced by arsenic,—proving in general quickly fatal,—and presenting the ordinary phenomena. I cannot help thinking therefore that the events now alluded to prove rather the ineffectiveness of the police where they happened, than the adroitness of the actors by whom they were brought about; and that they constitute no sound objection to the statement, that the art of secret poisoning is now unknown, and is not likely to be again revived.

It must be granted, indeed, that the late discoveries in chemistry and toxicology have made poisons known, which might be employed in such a way as to render suspicion unlikely, and to baffle inquiry. But the methods now alluded to are hitherto very little known; they cannot easily be attempted on account of the rarity and difficult preparation of the poisons; they can never be practised except by a person conversant with the minute phenomena of natural disease; and it is no part of the object of this work to make them public.

The Evidence, by which the medical jurist is enabled to pronounce on the existence or non-existence of poisoning in general, and to determine the subordinate questions that relate to it, is derived from five sources,—1. the symptoms during life;

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* *Feuerbach.* Actenmässige Darstellung Merkwürdiger Verbrechen, i. 1. For some observations on the three fatal cases, see the Chapter on Arsenic, under the head of the effects of that poison as an antiseptic.

2. the appearances in the dead body; 3. the chemical analysis; 4. experiments and observations on animals: and 5. certain moral circumstances, which are either inseparably interwoven with the medical proof, or cannot be accurately appreciated without medical knowledge.

SECTION I.—*Of the Evidence from Symptoms.*

Not many years ago it was the custom to decide questions of poisoning from the symptoms only. Till the close of last century, indeed, no other evidence was accounted so infallible: and for the simple reason, that in reality the other branches of evidence were even more imperfectly understood. So lately as 1763, and even in Germany, the solemn opinions of whole colleges were sometimes grounded almost exclusively on the symptoms*. About that time, however, doubts began to be entertained of the infallibility of such evidence; these doubts have since assumed gradually a more substantial form; and it is now laid down by every esteemed author in Medical Jurisprudence, that the symptoms, however exquisitely developed, can never justify an opinion in favour of more than high probability †. In laying down this doctrine medical jurists appear to me to have injudiciously confounded together actual symptoms with their general characteristics. If the doctrine is to be held as applying to the evidence from symptoms, only so far as they are viewed in questions of general poisoning,—that is, as applying to the general characters merely of the symptoms,—it is deduced from accurate principles. But if it is likewise to be applied, as recent authors have done, to the actual symptoms produced by particular poisons, and in all cases whatever of their action, then it is a rule clearly liable to several important exceptions. These exceptions will be noticed under the heads of the mineral acids, oxalic acid, arsenic, corrosive sublimate, nux vomica, &c. At present it is only the general characters of the symptoms, and the points in which they differ from the general characters of the symptoms of natural disease, that I propose to consider.

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* See an opinion of the Berlin College in *Pyl's* Repertorium für die gerichtlichen Arzneikunde, i. 244.

† *Orfila.* Médecine-Légale, ii. 360.
Henke. Lehrbuch der gerichtlichen Medizin. 448.
Tortosa. Istituzioni di Medicina Forense, ii. 86.
Beck's Medical Jurisprudence, 419.

The chief characteristics usually ascribed to the symptoms of poisoning considered generally, are, that they commence suddenly and prove rapidly fatal,—that they increase steadily,—that they are uniform in nature throughout their course,—that they begin soon after a meal,—and that they appear while the body is in a state of perfect health.

1. The first characteristic is the *suddenness of their appearance and the rapidity of their progress* towards a fatal termination. Some of them act instantaneously, and the effects of most of them are in general fully developed within an hour or little more. But this character is by no means uniform. The most violent may be made to act, so as to bring on their peculiar symptoms slowly, or even by imperceptible degrees. Thus arsenic, which usually causes violent symptoms from the very beginning, may be so administered as to occasion at first nothing more than slight nausea and general feebleness; and afterwards in slow succession its more customary effects. In like manner corrosive sublimate may be given in such a way as to cause at first mild salivation, and finally gangrene of the mouth. Even many vegetable poisons might be administered in the same way. The well-known consequences of digitalis in medicinal doses will serve as a familiar instance. A still better illustration is supplied by the medicinal effects of the alkaloid of nux vomica, whose action in other circumstances is most rapid and violent: Strychnia in a moderate dose will cause death by violent tetanus in two or three minutes; but when given in frequent small doses as a remedy in palsy, it has been known to bring on first stiffness of the jaw, afterwards pain and rigidity of the neck; and these effects might be increased so gradually, that the patient would seem to die under ordinary tetanus. Nevertheless, the foregoing considerations being kept always in mind, it still remains true, that the effects of poisons for the most part begin suddenly, when the dose is large. This is an important circumstance in regard to certain active poisons, such as the mineral acids, oxalic acid, arsenic, strychnia, &c. For when it is considered that in criminal cases they are almost always given in unnecessarily large doses, it follows that if the

effects ascribed to these poisons in such doses have not begun suddenly, the suspicion is probably incorrect.

The same remarks may be applied to the sudden termination of the symptoms. Poison is for the most part given criminally in doses so large that it proves rapidly fatal. Yet this is not always the case: the diseased state occasioned by poisons has often been prolonged, as will be seen hereafter, for several weeks, sometimes for several months; nay a person may be carried off by a malady, the seeds of which have been sown by the operation of poison years before.

The present would be the proper place for noticing the important question regarding the interval of time, after which, if death supervenes, it cannot be laid to the charge of the person who administered the poison. It is unnecessary, however, to say much on the subject. According to the English law, death must take place within a year. As to the Scottish law, it may be inferred from what has been said by the present Baron Hume on the subject of homicide generally, that a charge of poisoning is relevant, although the person should die at a period indefinitely remote, and that it will infer the pains of law, provided the operation of the poison can be distinctly traced, unmodified by extraneous circumstances, from the commencement of the symptoms to the fatal termination*. Of course the influence of these modifying circumstances in lessening the criminal's responsibility will increase with the interval. The question for the medical jurist to determine in such a case would therefore be, the distance of time to which death may be delayed in the case of poisoning generally, and in that of the particular poison. This question cannot be answered even with an approach to precision, except in the instance of a few common poisons. Most vegetable and animal poisons prove fatal either in a few days or not at all; but some mineral poisons may cause death after an interval of many days. It appears probable that arsenic may cause death after an interval of several months, and it is well ascertained that the symptoms of poisoning with the mineral acids have continued uninterruptedly and without modification for eight months, and then terminated fatally.

2. The next general characteristic of the symptoms of poisoning is *regularity in their increase*. It is clear, however,

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* Hume on Crimes, i. 178.

that even this character cannot be universal. For in all cases of slow poisoning by repeated small doses there must be remissions and exacerbations, just as in natural diseases. Besides, as we can seldom watch the symptoms advancing in their simple form, but must endeavour to remove them by remedies, remissions may thus be produced and their tendency to increase steadily counteracted. Farther, some poisons admit of exacerbations and remissions, even when given in one large dose; and there are others, the very essence of whose action is to produce violent symptoms in frequent paroxysms. Of the latter kind are nux vomica, and the other substances that contain strychnia. Of the former kind is arsenic: in cases of poisoning with arsenic it often happens, that after the first five or six hours have been passed in great agony, the symptoms undergo a striking remission for as many hours, and then return with equal or increased violence. Still it is true that on the whole the symptoms of poisoning are steady in their progress; so that this should always be attended to as one of the general characters. In the case of slow poisoning, too, when the most remarkable deviations from it are observed, the very occurrence of exacerbations and remissions, combined with certain points of moral proof, may furnish the strongest evidence possible. Thus, on the trial of *Miss Blandy* at Oxford in 1752, for the murder of her father, one of the strongest circumstances in proof was, that repeatedly after she gave the deceased a bowl of gruel, suspected to be poisoned, his illness was much increased in violence*.

As connected with the present subject, a question might here be noticed that has been discussed on the occasion of various trials, namely, whether the symptoms of poisoning are susceptible of a complete intermission. It cannot be answered satisfactorily, however, except with reference to particular poisons. The property alluded to has been ascribed to several poisons, even to mercury, arsenic, and opium; but oftener, I believe, in consequence of an improper desire on the part of the witnesses to prove or to perfect their view of the case, than through legitimate induction from facts.

3. Another characteristic is *uniformity in the nature of the symptoms* throughout their whole progress. This character is

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* Howell's State Trials, xviii. 1135.

the least invariable of them all; for many poisons cause very different symptoms toward the close from those which they cause at the beginning. Arsenic may cause at first inflammation of the alimentary canal, and afterwards palsy or epilepsy; nux vomica may excite at first violent tetanus, and afterwards inflammation of the stomach and bowels; and corrosive sublimate, after exciting in the first instance inflammation, may prove eventually fatal by inducing excessive ptyalism. In truth, certain changes of this kind in the nature of the symptoms will, in special cases, afford strong presumption, perhaps absolute proof, not only of general poisoning, but even also of the particular poison given.—The reason for mentioning so uncertain a character as uniformity in the nature of the symptoms among their characteristics will appear presently.—[Pp. 46 and 50.]

4. The fourth characteristic is, that *the symptoms begin soon after a meal*, or rather, soon after food, drink, or medicine has been taken. The occasions on which we eat and drink are so numerous and so near one another, that unless the poison suspected is one which acts with rapidity, it may be difficult to attach any weight to this circumstance. Some poisons rarely produce their effects till a considerable time after they are swallowed; the poisonous mushrooms, for example, may remain in the alimentary canal for several hours or even an entire day and more, before their effects begin; poisonous cheese in like manner may not act for five or six hours*, or even a whole day†; and that kind of cholera, which is caused in some people by putrid, and in others by new-killed meat, seldom begins, so far as I have observed, till twelve hours or more after the noxious meal. With regard to the commoner poisons, such as arsenic, corrosive sublimate, the mineral acids, oxalic acid, nux vomica, and the like, it is a good general rule, that the symptoms, if violent from the beginning, must have begun soon after food, drink, or medicine has been taken.

In making inquiries respecting this point, however, care must be taken not to lose sight of certain circumstances which may cause a deviation from the general rule.

In the first place, it should be remembered that poisons may be administered in many other ways besides mixing them with articles of food or drink, or substituting them for medicines. They may be introduced into the anus; they have been introduced into the vagina; they have also been introduced by inhalation in the form of vapour; and there can be no difficulty in introducing some of them through wounds.

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* *Hunefeld* in Horn's Archiv, 1827, i. 203.

† *Weiss* in Revue Médicale, Janv. 1826.

Secondly, another circumstance which may be kept in view is, that, if a person falls asleep very soon after swallowing a poison, especially one of the irritants, the commencement of the symptoms may be considerably retarded, provided it be not one of the powerful corrosives. This statement is not so fully supported by facts as to admit of its being laid down with confidence as a general rule. But from various incidents which have come under my notice it appears not improbable, that sleep does possess the power of putting off for a while the action of some poisons. In particular some instances have occurred to me where arsenic taken at night did not begin to act for several hours, the individual having in the meantime been asleep*. The occurrence of so long an interval between its administration and the first appearance of the symptoms is so contrary to what generally happens, that some cause or another must be in activity; and the insensibility of the system during sleep to most sources of excitement seems to supply a sufficient explanation. The slow operation of laxatives during sleep, compared with their effects during one's waking hours, is an analogical fact.

A third consideration to be attended to is, that poison may be secretly administered during sleep to a person who lies habitually with his mouth open. This is fully proved by an interesting case which will be noticed under the head of the Moral Evidence of Poisoning. In that particular case the individual immediately awoke, because the poison was concentrated sulphuric acid; but it may admit of question whether a sound sleeper might not swallow less irritating poisons without being awakened. In such circumstances no connexion of course could be traced between the taking of a suspected article and the first appearance of the symptoms.

5. Lastly, *The symptoms appear during a state of perfect health.* This is an important character, yet not universal; for it cannot be expected to apply to cases of slow poisoning, and poisons may be given while the person is actually labouring under na-

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* See subsequently the Chapter on Arsenic, Section ii.

tural disease. Cases of the last description are generally very embarrassing; for if, instead of medicine, a poison be administered, whose symptoms resemble the natural disease, suspicion may not arise till it is too late to collect evidence.

It must be apparent from the preceding observations, that the characters common to the symptoms of General Poisoning are by no means universally applicable. Yet on reviewing them attentively it will also appear, that, considering the little knowledge possessed by the vulgar of the action of poisons, and consequently the rude nature of their attempts to commit murder by poisoning, the exceptions to the general statements made above will not be numerous.

It now remains to be seen how far these characters distinguish the symptoms of poisoning from those of natural disease; and

1. As to *the suddenness of their invasion and rapidity of their progress*, it is almost needless to observe, that many natural diseases commence with a suddenness and prove fatal with a rapidity, which few or no poisons can surpass. The plague may prove instantaneously fatal; and even the continued fever of this country may be fully formed in an hour, and may terminate fatally, as I have once witnessed, at the beginning of the second day. Inflammation of the stomach also begins suddenly and terminates soon. Cholera likewise answers this description: I have known the characters of ordinary cholera fully developed within an hour after the first warning symptom, and frequently in hot climates, nay, in some rare instances even in Britain, it proves fatal in a few hours. Malignant cholera frequently proves fatal in a very few hours. Inflammation of the intestines, too, may begin, or at least seem to begin, suddenly and end fatally in a day: One variety of it lately described by *M. Louis* of Paris and other French pathologists, may remain quite latent till the gut is perforated by ulceration, and then the patient is attacked with acute pain, vomiting, and mortal faintness, and frequently perishes within twenty-four hours*. But in particular many organic diseases of the heart prove suddenly fatal, without any previous warning; and this is also true to a cer-

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* Archives Générales de Médecine, i. 17; also *Abercrombie* on Diseases of the Stomach, &c. 273.

tain extent even of apoplexy; for, as will afterwards be seen, it is an error to suppose that apoplexy is always, or even generally, preceded by warning symptoms. The first characteristic, therefore, as applied to the symptoms of poisoning generally, contrasted with those of general disease, must appear by no means distinctive. But opportunities will occur afterwards for showing, that it is sometimes a good diagnostic in the case of particular poisons*.

2. As to the uniformity or *uninterrupted increase of the symptoms*, it is equally the attribute of many common diseases. I am not aware, that in speedily fatal cases of the internal *phlegmasiæ* a considerable remission is often observed. Apoplexy, too, very frequently continues its course without interruption; and the same may be said of cholera, and indeed of most acute diseases, when they prove rapidly fatal.

3. It was stated above, that the third character, *uniformity in kind* throughout their progress, is by no means an invariable circumstance. Still less is it distinctive; for many diseases are marked by great uniformity of symptoms. It has been enumerated nevertheless among the general characters of poisoning, because, although its presence can hardly ever add any weight to the evidence in favour of death by poison, its absence may sometimes afford even positive proof in favour of natural death. That is, changes of a certain kind occurring in the symptoms during their progress may be incompatible with the known effects of a particular poison or of all poisons, and capable of being accounted for only on the supposition of natural disease having been at least the ultimate cause of death. This statement, which is one of some importance, is illustrated by a pointed case, that of *Charles Munn*, mentioned at the close of the present Section.

4. In the next place, it was observed that some reliance may be placed on the fact, that the symptoms of poisoning *appear very soon after a meal*. But we also know this to be the most frequent occasion on which some natural disorders begin. An attack of apoplexy after a hearty meal is a common occurrence. That kind of cholera which follows the immoderate use of acid fruit likewise comes on soon after eating. Sometimes mere excessive distension of the stomach after a meal proves sudden-

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* See Oxalic Acid and Nux Vomica.

ly or instantaneously fatal. Drinking cold water when the body is overheated likewise causes at times immediate death. It appears that perforation of the stomach, the result of an insidious ulcer of its coats, and likewise rupture of the stomach from mechanical causes, are most apt to occur during the digestion, and therefore soon after the taking of a meal.

These few observations will make it evident that the appearing of violent symptoms soon after eating may arise from other causes besides the administration of poison. At the same time, as the diseases which are apt to commence suddenly at that particular time are few in number, and none of them by any means frequent, it is always justly reckoned a very suspicious circumstance; and when combined with certain points of moral proof, such as that of several people, who have eaten together, being seized about the same time with the same kind of symptoms, the evidence of general poisoning becomes very strong indeed. Sometimes the evidence from the date of their commencement after a meal may singly supply strong evidence, as in the case of the mineral acids and alkalis, or corrosive sublimate, which begin to act in a few seconds or minutes.

On the other hand, if the symptoms do not begin soon after food, drink, or medicine has been taken (the circumstances being such as to exclude the possibility of poison being introduced by a wound, by the lungs, or by any other channel but the stomach), the presumption on the whole is against poisoning, and sometimes the evidence to this effect may be decisive. The principle now propounded may be often a very important one in the practice of medical jurisprudence; for when united with a little knowledge of the symptoms antecedent to death, it may be sufficient to decide the nature of the case. Thus it is sufficient, in my opinion, to decide the celebrated case of the *Crown Prince of Sweden*. The Prince, while in the act of reviewing a body of troops on the 28th May 1810, was observed suddenly to waver on his horse; and soon afterwards he fell off while at the gallop, was immediately found insensible by his staff, and expired in half an hour. As he was much beloved by the whole nation, a rumour arose that he had been poisoned; and the report took such firm root in the minds of all ranks, that a party of military, while escorting the body to Stockholm, were attacked near the city by the populace, and their commander, Marshall Fersen, murdered; and Dr Rossi, the Prince's physician, after narrowly escaping the same fate, was in the end obliged to quit his native country. Now, no other poison but one of the most active narcotics could have caused such symptoms, and none of them could have proved so quickly fatal unless given in a large dose. It was proved, however, that on the day of his death the Prince had not taken any thing after he breakfasted; and an interval of nearly four hours elapsed after that till he fell from his horse. This fact alone, independently of the marks of apoplexy found in the head after death, and the warnings he had several times before it, was quite enough to show that he could not have died of poison, as it was incompatible with the known action of the only poisons which could cause the symptoms. This is very properly one of the arguments used by the Medical Faculty of Stockholm, which was consulted on the occasion*.

The same circumstances will often enable us to decide at once a set of cases of frequent occurrence, particularly in towns,—where the sudden death of a person in a family, the members of which are on bad terms with one another, is rashly and ignorantly imputed to poison, without any particular poison being pointed at; and where consequently, unless the morbid appearances clearly indicate the cause of death, a very troublesome analysis might be necessary. In several cases of this kind, which have been submitted to me, I have been induced to dispense with an analysis by resting on the criterion now under consideration. The following is a good example.

A middle-aged man, who had long enjoyed excellent health, one afternoon about two o'clock returned home tired, and after having been well beaten by his wife went to bed. At a quarter past two one of his workmen found him gasping, [illegible] his eyes, and quite insensible; and he died in a few m[illegible] As his wife had often maltreated and threatened him [illegible] arose that he had died of poison, and the body [illegible] quence examined judicially by *Mr Newbigging* and [illegible] only appearance of disease we[illegible] detect was a [illegible] tuberculation of the septum [illegible] anterior par[illegible] ventricles. This disease mig[illegible] the caus[illegible] for there is no disease of the heart which may not remain long latent, and prove fatal suddenly. But, as the man never had a symptom referrible to disease of the heart, it was impossible to infer, in face of a suspicion of poisoning, that it must have been the cause of death; since the man might very well have died of poison, the disease of the heart continuing latent. Poisoning, however, was out of the question. The man had taken nothing whatever after breakfasting about nine. Now no poison but one of the most active narcotics in a large dose could cause death so rapidly as in this case; and the operation of such a poison in such a dose could not be suspended so long as from nine till two. An analysis was therefore unnecessary.

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* *Rossi.* Ueber die Art und Ursa[illegible] hochseligen von Schweden. Berlin, 1812.

5. Little need be said with regard to *the symptoms beginning, while the body is in a state of perfect health*; because in truth almost all acute diseases begin under the same circumstances. Connected with this subject, however, a point of difference should be noticed which may be of use for distinguishing poisoning by the irritants from acute diseases of the inflammatory kind:—the latter rarely begin without some adequate and obvious natural cause.

On considering all that has now been said regarding the characteristics of the symptoms of general poisoning, as contrasted with those of natural disease, no one can hesitate to allow, that from them alone a medical jurist can never be entitled to pronounce that poisoning was certain. At the same time he must not on that account neglect them. For, in the first place, they are of great value as generally giving him the first hints of the cause of mischief, and so leading him to search in time for better evidence. Next, they will often enable him to say that poisoning was possible, probable, or highly probable; which, when the moral evidence is very strong, may be quite enough to decide [illegible]. Thirdly, although they can never enable him to s [illegible] soning was certain, they will sometimes entitle him [illegible] he contrary, that it was impossible. And to concl [illegible] chemical or moral evidence proves that poison wa [illegible] haracter [illegible] the symptoms may be necessary to d [illegible] ther [illegible] he cause of death.

As the [illegible] is [illegible] ome consequence, and has been overlo [illegible] ical jurisprudence in this [illegible] ntry, it m [illegible] two comments. It does not follow, because a poison has been given, that it is the cause of death; and therefore in every medico-legal inquiry the cause of the first symptoms and the cause of death should be made two distinct questions. The question, whether a poison, proved to have been administered, was the cause of death, is to be answered by attending to the second and third characteristics mentioned above, and considering whether the symptoms went on progressively increasing, or altered their nature during the course of the patients' illness, and whether the alteration, if any, was such as may occur in the case of poisoning generally, or of the special poison given. These remarks are very well exemplified by a case, of which I have related the particulars elsewhere*, that namely of *Charles Munn*, tried at the Inverary Spring Circuit of 1824 for the double crime of procuring abortion, and of murder by poisoning. The moral evidence and symptoms together left no doubt that arsenic had been given, and that the deceased, a girl with whom the prisoner cohabited, laboured under the effects of that poison in a very aggravated and complex form for twelve days. After that she began to recover rapidly, and in the course of a fortnight more was free of every symptom except weakness and pains in the hands and feet: In short, all things considered, she was thought to be out of danger. But she then became affected with headach and sleeplessness, and died in nineteen days more under symptoms of obscure general fever, without any local inflammation. As neither Dr Duncan Junior nor myself, who were consulted by the Crown, had met with a parallel instance among the immense number of cases that are to be found in authors, we gave it as our opinion,—that granting the girl's first illness, as appeared from moral and medical evidence, was owing to arsenic, her death could not be ascribed to it with any certainty. It will be seen, indeed, on referring to the article Arsenic, that [illegible]ptoms, which preceded her death, coincide with t[illegible]h have been ascribed to it as the chief ingredient in th[illegible] *fana*. But it has been already stated that the fac[illegible] that poison are too questio[illegible]mitted am[illegible]ments of a medico-legal op[illegible]ent d[illegible]

So much, then, for the f[illegible]ce dr[illegible] characters of the symptom[illegible]ing.

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* Edinburgh Medico-[illegible] ii. [illegible]

to the example of others, I might consider in the present place the force of evidence derived from the symptoms themselves, which distinguish the three Classes of poisons. But this subject, together with the special natural diseases which imitate the symptoms of poisoning, will be treated of more conveniently as an introduction to each of the classes.

SECTION II.—*Of the Evidence from morbid appearances.*

The appearances left in the dead body after death by poison used formerly to be relied on as strongly as the symptoms during life; and with even less reason. Except in the instance of a very few poisons, the morbid appearances alone can never distinguish death by poison from the effects of natural disease, or from some other kinds of violent death. There is not much room, therefore, for general remarks under the present head.

It was at one time thought by the profession, and is still very generally imagined by the vulgar, that unusual blackness or lividity of the skin, indicates death by poison generally. But every experienced physician is now well aware, that excessive lividity is by no means universally produced by poison, and that it is likewise produced by so many natural diseases as not even to form, in any circumstances whatever, the slightest ground of suspicion. Neither is there any difference in kind, as some imagine, between the lividity which succeeds death by poison, and that which follows natural death. Yet it is right for the medical jurist to be aware that lividity as a supposed consequence of poison ought to be strictly attended to by medical inspectors and law officers while investigating charges of poisoning, because the vulgar belief on the subject sometimes leads to such conduct or language on the part of the poisoner as betrays his secret at the time, and constitutes evidence of his guilt afterwards.

A [illegible] ppearance equally unimportant is early putrefaction of [illegible] Early putrefaction, at one time much insisted on as a [illegible] poisoning*, cannot even justify suspicion. It is by [illegible] riably, or even generally caused by poisons; nay so [illegible] te precis [illegible] he reverse appears to be induced†; [illegible] quit [illegible] quently after natural death.

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[*] *Alberti,* [illegible] Medi [illegible] 4.

[†] See Arse [illegible]

Some other appearances, not more conclusive, might also be mentioned here; but they belong properly to the effects of individual poisons, or of classes of poisons, not to those of poisoning generally. It may merely be remarked at present, therefore, that the appearances after death, which are really morbid, and which may be produced by poisons, are, in one great class, the signs of inflammation of the alimentary canal in its progressive stages,—in another class, the signs of congestion within the head,—and in a third, a combination of the effects of the two preceding classes; that neither set of appearances is invariably caused by the poisons which usually cause them; that congestion within the head is really seldom produced by those which are currently imagined to produce it; and that most of the appearances of both kinds are exactly similar to those left by many natural diseases.

But although, on the whole, the appearances after death, when considered singly, can very rarely supply evidence of poisoning even to the amount of probability, they may nevertheless prove very important under other points of view. Thus, in connexion with the symptoms and the general evidence, the appearances after death may furnish decisive proof; and even should the history of the symptoms be unknown, or have been unskilfully collected, the appearances after death, by pointing out the nature of the previous illness, may furnish evidence enough to decide the case, when the moral proof is strong. Again, in cases of alleged *Imputation of poisoning* they are necessary to determine, whether a poison actually found in the body was introduced during life or after death. Besides, the very absence of morbid appearances may afford presumptive proof in some circumstances,—when, for example, the question is, whether a person has died of apoplexy or of poisoning with narcotics? Farther, a few poisons, as was formerly stated, occasionally produce appearances so characteristic, as not to be capable of being confounded with the effects of any other agent whatsoever: It will be found hereafter, for example, that the mineral acids have at times left behind them in the dead body unequivocal evidence of their operation. And finally, in cases where no doubt can be entertained that poison was taken, the evidence from morbid appearances may be useful or necessary for settling whether or not it was the cause of death. Two

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* Magazin für die gesammte

† Journal de Médecine, xxix.

‡ Aufsätze und Beobachtunger

tion he makes during an inquiry, and so be induced to conduct the rest of the inspection superficially; and likewise, that he should not so frame his opinion on the case, as to exclude the possibility of a different cause from the apparent one, unless the appearances are such as must necessarily have been the cause of death. It may be said, that in requiring this condition for an unqualified opinion, a rigour of demonstration is exacted, which can rarely be attained in practice. But, on the one hand, it must not be forgotten, that an unqualified opinion is not always necessary; and on the other hand, although it were, I think it might be shown, if the subject did not lead to disproportionate details, that we may often approach very near the rigour of demonstration required. At present no more need be said, than that the inspector should be particularly on his guard in those cases, in which the appearances, though belonging to the effects of a deadly disease, are trifling; and still more in those in which the appearances, though great, belong to the effects of a disease, whose whole course may be latent. And I may add, that, from what I have observed of medico-legal opinions, the caution now given is strongly called for.

It may be right to allude here also to another purpose which may be served by a careful consideration of the morbid appearances. In cases in which the history of the symptoms is unknown or imperfect the extent and state of progress of the appearances will sometimes supply strong presumptive evidence of the duration of the poisoning. This is an obvious and important application of the knowledge of the pathology of poisoning; but the simple mention of it is all which can be here attempted, as special rules can hardly be laid down on the subject.

SECTION III.—*Evidence from Chemical Analysis.*

The chemical evidence in charges of poisoning is generally, and with justice, considered the most decisive of all the branches of proof. It is accounted most valid, when it detects the poison in the stomach, intestines or gullet, then in the matter vomited, next in articles of food, drink or medicine of which the sufferer has partaken, and lastly, in any articles found in the prisoner's possession, and for which he cannot account satisfactorily.

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taken; but an account of the symptoms and appearances was necessary to prove that she died of it*.—The other case occurred to *Pyl* in 1783. A woman at Berlin, who lived on bad terms with her husband, went to bed in perfect health; but soon afterwards her mother found her breathing very hard, and on inquiring into the cause discovered a wound in the left side of the breast. A surgeon being immediately sent for, the hemorrhage, which had never been great, was checked without difficulty; but she died nevertheless towards morning. On opening the chest it appeared that the wound pierced into it, and penetrated the pericardium, but did not wound the heart; and although the fifth intercostal artery had been divided, hardly any blood was effused into the cavity of the chest. Coupling these circumstances with the trifling hemorrhage during life, and the fact that she had much vomiting, and some convulsions immediately before death, Pyl satisfied himself that she had not died of the wound: and accordingly the signs of corrosion in the mouth and throat, and of irritation in the stomach, with the subsequent discovery of the remains of some nitric acid in a glass in her room, proved that she had died of poison†.

The next point to be examined under the head of the chemical evidence, relates to the causes which may remove the poison beyond the reach of the inspector. Although poison be not detected in the body,—the experimenter being supposed skilful and the poison of a kind which is easily discovered,—still it must not be concluded from that fact alone that poison has not been the cause of death. For it may have been all discharged by vomiting and purging; or it may have been all absorbed; or decomposed.

1. It may have been discharged by vomiting and purging. Thus on the trial of George Thom for poisoning the Mitchells, held at Aberdeen at the Autumn Circuit of 1821, it was clearly proved, that the deceased had died of poisoning by arsenic; yet by a careful analysis none could be detected in the stomach or its contents; for the man lived seven days, and during all that time laboured under frequent vomiting ‡. In a remark-

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* *Wildberg.* Praktisches Handbuch für Physiker, iii. 227.

† Aufsätze und Beobachtungen, &c. ii. 122.

‡ Edinburgh Medical and Surgical Journal, xviii. 171.

able case related by Dr Roget, arsenic could not be found in the matter vomited twenty-four hours after it had been swallowed [*]; in another related by *Professor Wagner* of Berlin, that of an infant who died in twelve hours under incessant vomiting after receiving a small quantity of arsenic, none could be detected in the stomach [†]; in another, which I have described in a paper on arsenic, although the person lived only five hours, the whole arsenic which could be detected in the tissues and contents of the stomach did not exceed a fifteenth part of a grain [‡]; and in an American Journal there is a still more striking case of a grocer, who died eight hours after swallowing an ounce of arsenic, and in whose body none could be found by chemical analysis [§].

Nevertheless, it is singular how ineffectual vomiting proves in expelling some poisons from the stomach. Those which are not easily soluble, and have been taken in a state of minute division, may remain adhering to the villous coat, notwithstanding repeated and violent efforts to dislodge them by vomiting. Many instances to this effect have occurred in the instance of arsenic. *Metzger* has related a case, where, after six hours of incessant vomiting, three drachms were found in the stomach [‖]. *Mr Sidey*, a surgeon of this city, has mentioned to me an instance of poisoning with king's yellow, in which he found the stomach lined with the poison, although the patient had vomited for thirty hours. In three cases which I have investigated arsenic was detected, although the people lived and vomited much for nearly two days [¶]; and *Professor Orfila* has noticed a similar instance, in which that poison was found in the contents of the stomach, although the person had vomited incessantly for two entire days [**].

It is not easy to specify the period after which a poison that has excited vomiting need not be looked for in the stomach. It must vary with a variety of circumstances whose combined effect it is almost impossible to appreciate, such as the solubility and state of division of the poison, the frequency of vomiting, the substances taken as remedies, and the like. The facts quoted above will show that some poisons may frequently be found after two days' incessant vomiting; and on the whole it may be stated, that the recent improvements in analysis render the period much longer than it has generally been, and would naturally be, imagined. *Metzger* has related the case of a woman poisoned with arsenic mixed with currants, in whose body, after eight days of frequent vomiting, he found ten or twelve currants, which gave out an odour of garlick when burnt *; but here the dose, if there was really arsenic, must have been repeated recently before death, for it is not possible to conceive how currants could remain in the stomach so long, whatever may be thought of the possibility of arsenic remaining. It is farther proper to add, that *Professor Henke* of Erlangen, one of the highest living authorities in Germany, once found grains of arsenic in the gullet, although he found none in any other part of the body, of a person who survived the taking of the poison four days †. Allowing to this fact all the weight derived from the high name of its author, I must nevertheless express great doubt whether the arsenic was not repeated more recently before death.

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[*] London Medico-Chirurgical Transactions, ii. 158.

[†] Archiv für Medizinische Erfahrung, 1834, p. 754.

[‡] Edinburgh Medico-Chirurgical Transactions, ii. 303.

[§] New York Medical and Philosophical Journal, iii. No. 1.

[‖] De Veneficio caute dijudicando in *Schlegel's* Collectio opusculorum, &c. iv. 22.

[¶] Edinburgh Medico-Chirurgical Transactions, ii. 291, Edinburgh Medical and Surgical Journal, xxvii. 457, and xxix. 26.

[**] Archives Générales de Médecine, ii. 58.

2. The poison may have disappeared, because it has been all absorbed. It has several times happened that in the bodies of those poisoned with laudanum, or even with solid opium, none of the drug could be found after death. Sometimes indeed it is found, even though the individual survived the taking of the poison many hours. Thus a case is related by *Meyer* of Berlin, in which the person lived ten hours after taking the saffron-tincture of opium; and nevertheless it was detected in the stomach by a mixed smell of saffron and opium ‡. But more commonly it all disappears, unless the dose has been very large. In a case of poisoning with laudanum, which I examined here, along with Mr Newbigging, in 1823, none could be detected, although strong moral circumstances left no doubt that laudanum had been swallowed seven or eight hours before death.

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* Materialien für die Staatsarzneikunde, i. 130.

† Ueber die gerichtlich-medizinische Beurtheilung der Vergiftungen. *Kopp's* Jahrbuch, vii. 159.

‡ *Rust's* Magazin für die gesammte Heilkunde, iii. 24.

An instance of the same kind has been minutely related by *Pyl.* It was that of an infant who was poisoned with a mixture of opium and hyoscyamus, and in whose stomach and intestines none could be detected by the smell[*]. Similar observations have been often made on animals; and several additional cases of the same purport, occurring in man, will be related under the head of opium.

It might be of use to quote some of the numerous errors committed by medical witnesses, in consequence of having overlooked the effect of absorption in removing poisons beyond the reach of chemical analysis. But, not to be too prolix, I shall be content with mentioning a single very distinct case in point, which happened at a Coroner's Inquest in London, in 1823. A young man one evening called his fellow-lodger to his bedside; assured him he had taken laudanum, and should be dead by the morrow; and desired him to carry his last farewell to his mother and his mistress. His companion thought he was shamming; but next morning the unfortunate youth was found in the agonies of death. The moral evidence was not very satisfactory; but that is of little consequence to my present object. The point in the case I would particularly refer to is the declaration of the medical inspector, that laudanum could not have been taken, because he did not find any by the smell or by chemical analysis in the contents of the stomach[†].

3. Lastly, poisons may not be found, because the excess has been decomposed.

Vegetable and animal poisons may be altogether destroyed by the process of digestion. This observation will explain why sometimes no poison could be found in cases of poisoning with crude opium or other vegetable solids. A French physician, *M. Desruelles,* has related the case of a soldier, who died six hours and a half after swallowing two drachms of solid opium, and in whose stomach nothing was found but a yellowish fluid, quite destitute of the smell of the drug[‡].

Some mineral poisons, such as corrosive sublimate, lunar caustic, hydrochlorate of tin, are also decomposed in the stomach. But they are not removed beyond the reach of chemi-

[*] Aufsätze und Beobachtungen, viii. 92.

[†] Morning Chronicle, Jan. 8, 1823.

[‡] Journal Universel des Sciences Médicales, xix. 340.

cal analysis. The decomposition is the result of a chemical, not of a vital process; and the basis of the poison may be found in the solid contents of the stomach under some other compound form. Other poisons again may be apt to elude detection by altering their form in a different way, namely by combining with other substances, without themselves undergoing decomposition. Thus, it appears from a case related by *Mertzdorff* of Berlin, that, in poisoning with sulphuric acid, after the greater part of the poison is discharged by vomiting, the remainder may escape discovery by being neutralized: For, although he could not find any free acid in the contents of the stomach, he discovered 4½ grains in union with ammonia by precipitation with muriate of baryta[*].

It may be also right to mention another kind of decomposition which may render it impossible to detect a poison that has been really swallowed—namely that arising from decay of the body. In several recent cases bodies have been disinterred and examined for poison months or even years after death. In these and similar cases it would be unreasonable to expect always to find the poison, even when it existed in the stomach immediately after death. Some poisons, such as oxalic acid, might be dissolved and then exude; others, such as the vegetable narcotics, will undergo putrefaction; and others, such as prussic acid, are partly volatilized, partly decomposed, so as to be undistinguishable in the course of a few days only. The mineral poisons of course, those at least which are solid, are not liable to be so dissipated or destroyed. Some authors, indeed, have said, that arsenic may disappear in consequence of its uniting with hydrogen disengaged during the progress of putrefaction, and so escaping in the form of arseniuretted-hydrogen gas; and they have endeavoured to account in this way for the non-discovery of it in the bodies of people who had been killed by arsenic, and disinterred for examination many months afterwards[†]. But the supposition is by no means probable: at least arsenic has been detected in the body fourteen months, nay even seven years, after interment. For farther details on this curious topic the reader may turn to the article Arsenic.

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[*] *Horn's* Archiv für Medizinische Erfahrung, 1823, i. 451.

[†] *Bachmann.* Einige auserlesene gerichtlich-medizinische Abhandlungen, von Schmitt, Bachmann, &c. p. 21.

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pointed at by the medical evidence, but where a whole class of poisons must be kept more or less in view. Even here I apprehend there may be sufficient evidence in the symptoms and morbid appearances, without any chemical facts,—to render poisoning so highly probable, that in conjunction with strong moral evidence, no sensible man can entertain any doubt on the subject. Several illustrations might be here given; and some will be found scattered throughout the work. In the present place an instance will be mentioned which cannot be conveniently arranged any where else, and which is well worthy of notice, as being one of the most striking examples I have met with, where a court of law had to decide without chemical evidence.

A man of doubtful character and morals, well acquainted with chemistry and medical jurisprudence, and of disordered finances, was known to harbour a design on a friend's wife, who possessed a considerable fortune. At last he one morning invited the husband to breakfast with him at a tavern; and they breakfasted, in a private apartment, on beef-steaks, fried potatoes, eels, claret, and rum. They had scarcely commenced the meal when his guest complained of feeling unwell; and soon afterwards he vomited violently. This symptom continued, along with excruciating pain in the belly, for a long time before the prisoner sent for medical aid; indeed he did not procure a physician till the sufferer had been also attacked with very frequent and involuntary purging. The physician, who, before seeing his patient, had received the prisoner's explanation of the apparent cause of the illness, was led at first to impute the whole to cholera caught by exposure to cold; but on returning at seven in the evening, and finding the gentleman had been dead for an hour, he at once exclaimed that he had been poisoned. On the body being inspected much external lividity was found, contraction of the fingers, and great inflammation of the stomach and intestines, presenting an appearance like that of gangrene*. On analyzing some fluid left in the stomach, no arsenic or other poison could be detected. The attention of the inspectors was turned specially to arsenic, because the prisoner was proved to have bought that poison, and to have made a solution of some white powder in his kitchen not long before the deceased died. The prisoner in his defence stated, that the de-

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SECTION IV.—*Eviden*

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* *Marx*. die Lehre von den Gif
Criminal-Rechts-Pflege, I. i. 1.

ed to contain poison is more equivocal than was once imagined. But it may be doubted whether some medical jurists have not overstepped the proper limits, when they hold it to constitute little or no proof at all.

Evidence from express experiments should rarely form part of a regular medical inquiry into a charge of poisoning. For in the first place, to make sure of performing an experiment well requires more experimental skill than the generality of practitioners can be expected to possess; then, as will be seen in the sequel, evidence procured from this source can very rarely be more than presumptive; and lastly, if the quantity of poison in the suspected substance is great enough to affect one of the perfect animals, it may be recognized to a certainty by its physical or chemical properties.

For these reasons it is not likely, that, in an inquiry undertaken by a skilful toxicologist, he will put himself in the way of delivering an opinion on the force of such evidence. But it is nevertheless necessary for me to consider it in detail, because he may have to give his opinion regarding experiments made inconsiderately by others, or accidents caused by domestic animals receiving the remains of a suspected dish.

The matter subjected to trial may be either suspected food, drink, or medicine, or it may be the stuff vomited during life, or found in the stomach after death.

1. The evidence derived from *the effects of the suspected food, drink, or medicine* is better than that drawn from the effects of the vomited matter or contents of the stomach. But an important objection has been made to both, namely, that what is poison to man is not always poison to the lower animals, and that, on the other hand, some of the lower animals are poisoned by substances not hurtful to man.

A good deal of obscurity still hangs over the relative effects of poisons on man and the lower animals. There are two species, however, whose mode of life in respect to food closely resembles our own, and which, according to innumerable experiments by Orfila, are affected by almost all poisons exactly in the same way as ourselves, namely the cat and dog, but particularly the latter.

In general poisons act less violently on these animals; thus two drachms of opium are required to kill a middle-sized dog;* while thirty-six grains have killed a man, and in all probability a much less quantity would be sufficient for the purpose. It appears that one poison, alcohol, acts more powerfully on them than on man. There are also some poisons, such as opium, which, although deleterious to them as well as to man, nevertheless produce in general different symptoms. Yet the differences alluded to are probably not greater than exist between man and man in regard to the same substances; and therefore it may be assumed, that, on the whole, the effects of poisons on man differ little from those produced on the dog and cat.

The present objection is generally and perhaps justly considered a stronger one, when it is applied to other species of animals. But it must be confessed after all, that our knowledge of the diversities in the action of poisons on different animals is exceedingly vague, and founded on inaccurate research; and there is much reason to suspect, that, if the subject is studied more deeply, the greater number of the alleged diversities will prove rather apparent than real. Both reasoning and experiment, indeed, render it probable, that some orders, even of the perfect animals, such as the *Ruminantia*, are much less sensible than man to many poisons, and especially to poisons of the vegetable kingdom. But so far as may be inferred from the only accurate inquiries on the subject, their effects differ in degree more than in kind. Some exceptions will without doubt be found to this statement. For example, oxalic acid, besides inflaming the stomach, causes violent convulsions in animals, but in man it for the most part excites merely excessive prostration; and opium most generally excites in man pure sopor, in animals convulsions also. Other exceptions, too, exist by reason of functional peculiarities in certain animals. Thus irritant poisons do not cause vomiting in rabbits or horses, because these animals cannot vomit; neither do they appear to cause much pain to rabbits, because rabbits have not the power of expressing pain with energy. But exceptions like these, and particularly of the variety unconnected with functional peculiarities, will probably prove fewer in number, and less striking than is currently imagined. For it is, on the other hand, well ascertained, that many, indeed most of the active poisons whose effects have been examined by a connected train of experiments, produce nearly the same effects on all animals whatever from the highest to the lowest in the scale of perfection. It has been fully proved, that arsenic, copper, mercury, the mineral acids, opium, strychnia, veratrum album, hydrocyanic acid, cyanogen gas, sulphuretted hydrogen, and many others, produce nearly the same effects on man, quadrupeds, birds, amphibious animals, and even on fishes and insects[*].

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* *Charret*, in Revue Médicale, 1827, i. 514.

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[*] As a specimen of the vague, desultory, and erroneous nature of the investigations which have been made by authors on this subject, I may quote some late remarks published by *Virey* in the Journal Universel, (vi. 26.) and drawn, he says, from a comparison of statements in various works. He states that arsenic, which is so fatal to animals in general, merely purges dogs and wolves more or less; that nux vomica is less fatal to man than to dogs; that pepper is fatal to hogs, parsley to parrots, the agrostis arundinacea to goats, elder-berries to poultry, chenopodium vulvaria to swine; that on the contrary the goat eats with impunity hemlock, daphne gnidium, and some species of euphorbia; that the camel eats all species of euphorbia, the hedgehog cantharides, the horse monkshood, ranunculus flammula, buckthorn; asses and mules white hellebore, swine yew-berries; all which are poisonous to animals in general. He does not state special authorities for these facts, but they are taken from authors not of the most modern times, and must be received, in my opinion, with great reserve, notwithstanding the respect which M. Virey claims for the older writers.

In a more recent paper *Virey* lays it down as a general principle, that poisons from the inorganic kingdom act more or less on the whole animated creation, but that vegetable and animal poisons are such only in respect to particular animals; that carnivorous animals are more sensible to the action of vegetable poisons, but less so to that of animal poisons, than herbivorous or graminivorous animals; and that the activity of poisons on different animals bears a ratio in the first place to their relative sensibility, and secondly, to the digestive power of their stomach. I question whether these views will be generally admitted by toxicologists, without much more extensive and more careful inquiries than any hitherto made. [Journ. de Chim. Méd. vii. 314.]

Another singular illustration of the facility with which facts are admittted in proof of the varying effects of poisons on different animals, is a statement lately made by a German naturalist, *Dr Lenz*, to the effect that the hedgehog altogether resists the most powerful poisons. He states that he has seen one receive ten or twelve wounds from a viper on the ears, muzzle, and tongue, without sustaining any harm; and that ultimately it kills and devours the snake. He quotes Pallas for the fact that it has taken 100 cantharides flies without injury, and says a medical friend who wished to dissect a hedgehog, gave it successively hydrocyanic acid, arsenic, opium, and corrosive sublimate, without being able to kill it. [L'Institut. ii. 84.] His countryman *Reich*, however, contradicts these statements, observing that he has poisoned the hedgehog with hydrocyanic acid, arsenic, and corrosive sublimate, but that doses considerably larger are required than for a dog or cat. Ninety grains of medicinal hydrocyanic acid, thirty of arsenic, and twenty of corrosive sublimate, occasioned death. [Annalen der Pharmacie, i. 358.]

The following experiments by *Professor Gohier* of the veterinary school of Lyons are worth mentioning; but in order to be satisfactory would require to be per-

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sickness, griping, swelling, and dizziness; and they added, that a cat was seized with convulsions after eating a part of it, had sprung away, and never returned. A large portion of the loaf was therefore sent to the Medical Inspector of the district; who reported, that it seemed exactly similar to another unsuspected loaf,—that, although he was not able to detect any poison, it might after all contain some,—vegetable poison particularly,—but that he could hardly believe it did, for he fed a dog, a cat, and a fowl several days with it, and they not only did not suffer any harm, but even appeared very fond of it[*]. In this case it was clear that poisoning was out of the question. On the other hand, the effects of some poisons on man may be developed so characteristically in animals as likewise to supply very pointed evidence. Thus, in the case of Mary Bateman, an infamous fortune-teller and charm-worker, who after cheating a poor family for a series of years, at last tried to avoid detection by poisoning them, it was justly accounted good evidence, that a portion of the pudding and the honey, supposed to have been poisoned, caused violent vomiting in a cat, killed three fowls, and proved fatal to a dog in four days, under symptoms of irritation of the stomach such as were observed in the people who died[†].

It has been farther objected to experiments on animals with suspected articles of food, drink, or medicine, that it is difficult to administer poison to them in a state of concentration, and to prevent it from being discharged by vomiting. This objection, however, may be obviated by performing the experiment in the way recommended by Professor Orfila. He makes a small opening into the gullet, previously detached from its surrounding connexions, then introduces all the liquid part by a funnel thrust into the opening, and next squeezes down the solid portions previously made into little pellets. Lastly, he ties the gullet under the aperture. The immediate effect of the operation is merely an appearance of languor ; and no very serious symptom is observable till four or five days at soonest after the tying of the gullet. Hence if signs of poisoning commence within forty-eight hours, they are independent of the injury done by the operation[‡]. This process requires some

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[*] *Pyl's* Aufsätze und Beobachtungen, i. 29.

[†] Celebrated Trials, vi. 55.

[‡] Toxicologie Générale, ii. 676.

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* Journal des Progrès des Science
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had led the reporters from this and other circumstances to declare, that in their opinion death was not owing to poison[*].

The last objection is a very important one; but there is reason for suspecting that it has been a good deal exaggerated by medical jurists.—Animal fluids are certainly poisonous when putrid. The repeated and fatal experience of anatomists, together with the precise experiments of *M. Gaspard* and *M. Magendie* [†], leave no doubt that putrid animal fluids, when introduced into an external wound, cause spreading inflammation of the cellular tissue; and although Majendie says he has found such fluids harmless when introduced into the stomach of dogs [‡], it is very probable, from their effects on man, that they will act as irritants on animals not habituated to their use. I believe, too, that independently of putrefaction, vomited matter or the contents of the stomach may be apt to make dogs vomit on account of their nauseous taste; and perhaps we may infer, that they will also cause some of the other symptoms of poisoning with the irritants, particularly if not vomited soon after being administered.—As to the influence of disease in rendering the contents of the stomach deleterious, it is to be observed that the effects just mentioned are probably owing to the influence of disease on the secretions, but that beyond this we know very little of the subject. In authors I have hitherto found only one fact to prove that disease can render the contents of the stomach decidedly poisonous; and on the negative side of the question there exist no facts at all. Morgagni tells us, that, in the case of a child who died of tertian ague, and in the midst of convulsions, an æruginous bile found in the stomach was so deleterious, that a little of it given with bread to a cock caused convulsions and death in a few minutes, and a scalpel stained with it, when thrust into the flesh of two pigeons, killed them in the same manner [§]. It is not easy to say what should be thought of this experiment; which, if admitted to the full extent of the conclusions deducible from it, would lead to the admission, that disease may impart to the secretions the properties of the most

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[*] Journal de Chimie Med. vii. 131.

[†] Journal de Physiologie, ii. 1, and iii. 81.

[‡] Ibid. iii. 84.

[§] De Sedibus et Causis Morborum, T. ii. Ep. lix. 18.

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be discovered in the stomach by certain methods of analysis; and that, although corrosive sublimate is a powerful irritant, the villous coat of the stomach was not inflamed. But then it was proved by experiments made by one of their number, *Dr Bostock*, that animals might be killed with corrosive sublimate without the stomach being inflamed, and without the poison being discoverable after death by the tests he used in the case[*]. An attempt was made on the side of the prisoner to throw out this line of evidence as incompetent, on the ground of the discrepant effects of poisons on man and on the lower animals. But it was admitted by the judge, on the plea that it was only to illustrate a general physiological fact, and not to infer proof of poisoning. The importance of experiments on animals to settle incidental physiological questions has lately been again acknowledged in a very pointed manner in an English court of law: for a set of experiments to settle the question of the rapidity with which hydrocyanic acid acts was instituted before the trial by the medical witnesses, at the request of the judge who was to try the case[†].

SECTION V.—*Of the Moral Evidence.*

It is not any part of my object to treat under this head of the moral evidence generally, which is required to establish a charge of poisoning. But as it is well known that medical witnesses have for the most part nothing to do with the moral proof, while at the same time in cases of poisoning the medical and moral circumstances are always intimately interwoven and apt to be confounded together, it is necessary for me to specify those particulars of the moral evidence, which either require some medical skill to appreciate them, or fall naturally under the cognizance of the physician in his quality of practitioner. I shall enter into greater details under this section than may perhaps appear to the medical reader necessary, chiefly that I may redeem the pledge given in the introduction to the lawyer and general reader, and endeavour to show how powerful an instrument a medico-legal investigation may be-

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[*] Trial.—This is a good illustration. Nevertheless, it will be seen under the head of the morbid appearances caused by the irritant class of poisons, that Dr Bostock's experiments, though conclusive as to the statement in the text, did not affect the real questions in the case.

[†] See trial of Freeman—*article* Hydrocyanic Acid.

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Upon many of the particulars now enumerated, important evidence may be derived from the medical part of the investigation; and not unfrequently such evidence can be collected or appreciated only by means of a medico-legal inquiry.

1. and 2. On the two first articles, suspicious conduct or conversation on the part of the prisoner before the crime, and the possession or purchase of poison by him, little or nothing need be said. The medical witness may of course be asked whether the conduct or conversation proved betokens an unusual acquaintance with poisons and their effects. And his opinion may be referred to regarding the nature of suspected articles found in the prisoner's possession. On the subject of the purchase of arsenic under the false pretence of poisoning rats, it may be observed, that a great deal more stress is usually laid on such evidence than it seems to deserve, as there are few houses, in the country particularly, which are not more or less infested by them. On the other hand, too little weight is attached to the circumstance of the purchaser not having warned his household of poison being laid. Such conduct ought in my opinion to be accounted extremely suspicious; for so far as I have remarked, the fear with which unprofessional persons regard the common poisons is such, that I can hardly believe any master of a house would actually lay poison without warning the servants and other inmates of his having done so.

3. The next article, which relates to the proof of the administration of poison, will require some details.

Direct proof of the administration of poison by the actual giver is very rarely attainable, that part of the transaction being for the most part easily concealed. The proof of this point is justly accounted, however, a very important part of the evidence; nay on some trials the prosecution has failed apparently for want of such evidence, although the case was complete in every other particular. It is generally constituted by a chain of circumstances, and these are often strictly medical, as will now be shown by a few examples.

In the first place, pointed evidence as to the individual who gave the poison may be derived from the chemical investigation,—for example, from the comparative results of the analysis of the poisoned dish, and of the articles of which it consisted. I am indebted to my colleague *Dr Alison* for the

following excellent illustr
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flour-mill to be ground, which had been intended originally for seed, and sprinkled with arsenic to destroy insects*.

It may be worth while observing in the present place, that in the instance of poisoned wine very important evidence may be obtained by examining whether the wine with which the cork is impregnated contains any traces of the poison. This method of investigation occurred to me in a very singular case of poisoning with arsenic in champaigne, which lately happened in a Baronet's family in Scotland. In this instance, however, such analysis was proved to be unnecessary; for the gentleman himself brought the bottle from his cellar, broke the wires and drew the cork, immediately before the wine was drunk †.

All evidence of the like nature, though it is at present often procured from other sources, should, for obvious reasons, be invariably collected, if possible, with the aid of a medical person. If again a medical man is called to a patient evidently affected with suspicious symptoms, and finds himself obliged to declare such to be his opinion, his thoughts, as soon as he has given directions for the treatment, should be turned towards that part of the evidence, for the securing of which he is naturally looked to as the person best qualified by previous education and his opportunities at the moment. With this view, therefore, having ascertained in what articles it is possible for poison to have been administered, he should at once endeavour to secure the remains of the particular portion partaken of by his patient, as well as of the general dish, if it is an article of food, and of the ingredients of which the dish was ostensibly made, not forgetting the salt with which it was seasoned. A case occurred not long ago in the North of Scotland, in which arsenic was administered in porridge by mixing it with the salt.

It is of great consequence, before proceeding to analyze such articles, for example suspected dishes,—to be particular in investigating every thing connected with the cooking, serving, and eating of them. By doing so, not only will the chemical analysis be facilitated, but likewise facts in it will be account-

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* I have unfortunately mislaid the reference to this interesting fact, which was taken, I think, from a recent French periodical. In this country arsenic is never employed for the purpose mentioned in the text.

† Edinburgh Med. and Surg. Journal, xxxiii. 67.

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the man got these stains while endeavouring to force his intoxicated wife to take the poison. Marks of nail-scratches were also observed round the mouth and on the throat; whence it was reasonably inferred, that, having failed in his original plan, he had suffocated her with his hands.[*]

While these illustrations are given of the conclusiveness of the chemical evidence in fixing the administration of poison on a particular individual, it is essential likewise to observe that the same kind of evidence may be at times equally conclusive of the innocence of a person unjustly suspected. This obvious and important application of a chemical inquiry is forcibly suggested by the following particulars of an incident related by *M. Chevallier*:—An individual was accused by a woman of having tried to poison her; and she represented that he had put the poison into her soup, while it stood from one day to another in an iron pot. On making a careful analysis of some of the soup which remained, Chevallier found it so strongly impregnated with copper, that, supposing the sulphate was the salt mixed with the soup, ten ounces must have contained twenty-two grains. It then occurred to him, that it was important to examine the iron pot, in which the poisoned soup was represented to have been kept; for the probability was that a large quantity of the copper, if any salt of that metal had really been contained in the soup, would have been thrown down by the superior affinity of the iron, and consequently that a coppery lining would be found on the inside. He was led, however, to anticipate that no copper would be found there, because there was no iron dissolved in the soup, as would have been the case if copper had been precipitated from it by the iron of the pot. And accordingly he not only found no copper lining the inside of the pot; but likewise on following the process described by the accuser as the one pursued in cooking the soup and in subsequently poisoning it, he satisfied himself by express trial that there was nothing in the circumstances of the case which could have prevented the iron from exerting its usual action on the salts of copper. These conclusions, coupled with certain facts of general evidence, proved substantially that the suspected person had nothing to do with the crime charged against him; and he was

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[*] Archives Générales de Médecine, xxi. 364.

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[*] Journal de Chimie Médicale,

[†] Edin. Med. and Surg. Journal

did not appear for eight hours after taking of the draught, I stated in my evidence that it was improbable the dose, if it contained arsenic at all, contained a quantity sufficient to cause the violent symptoms and death which followed *.

The correspondence in point of time between the appearance of symptoms of poisoning, and the administration of suspicious articles by an individual, constitutes still more decisive proof in a set of cases, in which it is of great value, as the chemical evidence is generally defective,—namely, where poisoning is attempted with repeated moderate doses. If the several renewals or exacerbations of illness correspond with the periods when suspicious articles have been given by the same individual, the circumstantial evidence of the administration may be even tantamount to direct proof. Thus, on the trial of Miss Blandy for the murder of her father, it was proved, that Mr Blandy on several occasions, after the prisoner received certain suspicious powders from her lover, was taken ill with vomiting and purging; and that on two occasions recently before his death, when he got from his daughter a bowl of gruel which contained a gritty sediment, he was attacked after a very short interval with pricking and heat in the throat, mouth, stomach, and bowels,—with sickness, vomiting, gripes, and bloody diarrhœa†. Here the proof of administration by the prisoner was complete.

These examples will show how the evidence of a particular person's criminality may be affected by the relation subsisting in point of time between the commencement of the symptoms and the suspicious administration of particular articles. But farther, the special period at which the symptoms begin may even at times supply strong evidence of his instrumentality, although there may be no direct proof from general evidence of his having been concerned in administering any thing whatever in a suspicious manner. This statement is well exemplified by the case of Mrs Humphreys, who was convicted at the Aberdeen Autumn Circuit in 1830 for poisoning her husband, by pouring sulphuric acid down his throat while he was asleep.

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* Edin. Med. and Surg. Journal, xxvii. 441. On considering, however, this and other instances of the kind which have since come under my notice, I suspect the case is rendered intelligible by the effect of sleep in suspending or delaying for a time the action of arsenic and other simply irritating poisons. See above—*evidence from symptoms beginning soon after a meal*, p. 43,—also *article* Arsenic.

† Howell's State Trials, xviii.

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* Edinburgh Med. a

and in regard to any of the common poisons this knowledge is sufficiently constituted by his simply knowing its name.

In some cases, however, the exact nature of the poison is not established with certainty; and then something else may be required to prove the prisoner's knowledge, and through that knowledge his intent. In the case of Charles Munn, formerly alluded to, [p. 50,] arsenic was the poison presumed to have been taken by the deceased. But the purchase or possession of it by the prisoner was not for some time satisfactorily established: neither was there any chemical evidence, the deceased having lived forty days and upwards after taking the poison. It was proved, however, that whatever it was which had been administered, the prisoner knew very well that what he gave was deleterious; because he persuaded the deceased, who was pregnant by him, to take it by assigning to it properties which no drug either possesses, or is so much as thought by the vulgar to possess. On one occasion he persuaded her that it would show whether she was with child, and on another that it would prevent people knowing she was with child. In such cases, then, good evidence may be derived from the arguments used by the giver to persuade his victim to take the poison; and sometimes, as in the instance now mentioned, it will lie with the medical witness to inform the court whether or not the reasons assigned are false.

Sometimes it has been pleaded by the prisoner that he gave the poison by mistake. In all such cases, if he descends to particulars, which he cannot help doing, there is every likelihood that the falsehood of the defence will be made evident by the particulars of the story not agreeing with other particulars of the moral or medical evidence. At present it is only necessary to allude to inconsistencies in his story with the medical facts. No general rules can be laid down on the method of investigating a case with a view to evidence of this kind: I must be satisfied with an illustration from an actual occurrence. On the trial of Mr Hodgson, a surgeon, at the Durham Autumn Assizes in 1824, for attempting to poison his wife, it was clearly proved, that pills containing corrosive sublimate, and compounded by the prisoner, were given by him to her in place of pills of calomel and opium, which had been ordered by her physician. But it was pleaded by him, that, being at the time

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sion[*]. But I am not aware, that, among the diseases which resemble well marked cases of poisoning either with irritants or with narcotics, any one ever originates in such a way as to render it possible for several persons in a family to be attacked simultaneously, except through the merest and therefore most improbable accident. Cholera perhaps is an exception. But when cholera attacks at one time several people living together, it arises from bad food, and is properly a variety of poisoning. In such cases, too, the fallacy may in general be easily got the better of, by finding that the store or stock, from which the various articles composing the injurious meal have been procured, was of wholesome quality.

Hence it may be laid down as a general rule, that, perhaps if two, but certainly if three or more persons, after taking a suspected article of food or drink, are each affected with symptoms, furnishing of themselves presumptive evidence of poisoning, and have been seized nearly about the same time, and within the interval after eating within which poisons usually begin to act,—the proof of poisoning is decisive. Several late cases might, in my opinion, have been decided by this rule. Thus it might have decided the important case of George Thom tried at Aberdeen in 1821 for poisoning the Mitchells, and likewise that of Eliza Fenning, about whose condemnation some clamour was made in London in 1815. In both instances, as will be mentioned under the head of arsenic, the symptoms were developed so characteristically, that from them alone poisoning with arsenic might have been inferred almost to a certainty. But even if the symptoms had been somewhat less characteristic, all doubt of general poisoning was set aside by the fact, that four persons in the former case, and five in the latter, were similarly and simultaneously affected, and all of them at an interval after eating, which corresponded with the interval within which arsenic usually begins to act.

Sometimes it happens, that while one or more of a party at a certain meal suffer, others escape. Such an occurrence must not be hastily assumed as inconsistent with poison having been administered at that meal. For the guilty person may have slipped the poison into the portion taken by the individual or individuals affected.

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[*] For a very striking example of the latter description see *Hufeland's* Journal der Praktischen Heilkunde, xii. i. 110. Fourteen people were seized about the same time in a charity workhouse.

If it is proved that all who ate of a particular dish have suffered, and all who did not have escaped, the kind of moral evidence now under review becomes strongest of all. It is well for the medical jurist to remember also, that such evidence is very useful in directing him where chiefly he should look for poison.

At other times it happens, that the several people affected, suffer in proportion to the quantity taken by each of a particular dish. Too much importance ought not to be attached to the absence of that relation; for it has been already mentioned that habit, idiosyncrasy, and the state of fulness of the stomach at the time, will modify materially the action of poisons. But when present, it will often form strong evidence.—A good illustration of what is now said may be found in the case of Thomas Lenargan, tried in Ireland for the murder of his master, Mr O'Flaherty. He had for some time carried on an amour with O'Flaherty's wife; and afterwards, to get rid of the troublesome surveillance of the husband, contrived to dispatch him by poison. The crime was not suspected for two years. Among the facts brought out on the trial the most pointed were, that O'Flaherty's daughter and two servants were affected at the same time with the very same symptoms as himself; that they had partaken of the same dish with him; that the severity of their several complaints was in proportion to the quantity each had taken; and that others of the family, who did not eat it, were not affected[*].

Another remarkable instance of this kind has been recorded by *Morgagni*. A clergyman, while travelling in company with another gentleman and two ladies, was setting out one afternoon to resume his journey after dining at an inn, when he was suddenly taken ill with violent pain in the stomach and bowels, and soon after with vomiting and purging. One of the ladies was similarly affected, but in a less degree; and likewise the other gentleman, though in a degree still less; but the other lady did not suffer at all. Morgagni found, that this lady was the only one of the party who had not tasted a dish of soup at the commencement of dinner. But he was puzzled on finding that the gentleman who suffered least had taken the largest share of the soup, while the clergyman had taken less than either of the two who were seized along with him. He then remembered, however, that in the district where the accident happened, it was the custom to use scraped cheese with the soup in question; and on inquiry he was informed that they had each added to the soup a quantity of cheese proportioned to the severity of their illness. Here, therefore, Morgagni was led to suspect the presence of poison; and accordingly, after the whole party had fortunately recovered, the innkeeper acknowledged, that in the hurry of preparation, he had served up to his guests cheese seasoned with arsenic to poison rats*. This interesting anecdote shows, that the truth in such cases is not always to be discovered without minute inquiry and considerable adroitness.—In the case of poisoning with arsenic in wine formerly alluded to,—where all the individuals at table, to the amount of six, were severely affected during dinner,—the soup was the article suspected, because all had partaken of it; and, accordingly, the soup and vomited matter were sent to me for analysis. On detecting a trace of arsenic in the vomited matter, but none in the soup, I suggested that some other article might have been used in common by the party, and mentioned the wine as a probable article of the kind. It turned out that all had drunk a single glass of champagne from a particular bottle; and in the wine remaining in this bottle arsenic was found in the proportion of half a grain per ounce †.

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[*] Having mislaid the copy I possessed of this trial, I am unable to give here the reference.

Cases of this nature are so instructive that no apology need be made for mentioning one example more which lately came under my own notice. In the case of Mary Anne Alcorn, convicted here in the summer of 1827, of having administered poison to her master and mistress (a case already referred to for another purpose [p. 77]), it was proved that a white powder was introduced in a suspicious manner into the gravy of baked beef, which gravy was subsequently poured over the beef. Now the master of the family dined heartily on beef, potatoes and rice-pudding, and mixed the greater part of the beef gravy with his pudding; the mistress ate moderately of the first slices

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* De Sedibus et Causis Morborum, T. ii. Ep. lix. 7.

† Edin. Med. and Surg. Journal, xxxiii. 67.

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most unnecessary to add, that in acting as now recommended, the physician must conduct himself with great circumspection, in order to avoid giving unnecessary offence, or alarming the guilty person.

7. and 9. On the seventh article, which respects the conduct of the prisoner after the death of the deceased, and on the ninth, which relates to the existence of a motive or inducement to the crime, nothing need be said here. But on the

8th article of the moral evidence,—comprehending the death-bed declaration of the deceased, his state of mind, his personal circumstances, and other points which prove the possibility or impossibility of voluntary poisoning,—a few remarks are required, because an important and little understood part of the practitioner's duty is connected with this branch of the proof.

The question of the possibility of voluntary poisoning is undoubtedly one upon which the medical attendant will be expected to throw some light, and into which he will also naturally inquire for his own satisfaction. In doing so his attention will be turned to circumstances purely moral, which may not only decide that question, but may also criminate a particular individual. His inquiries must therefore be conducted with discretion, and for obvious reasons should be confined as much as possible to the patient himself. They are to be conducted not so much by putting questions, as by leading him to disburden his mind of his own accord; and it is well to be aware that there is no one of whom a patient is so ready to make a confidant on such an occasion as his medical attendant.

If disclosures of consequence are made, and the attendant should feel it his duty to look forward to the future judicial proceedings and to the probability of his appearing as a witness, he ought to remember the general rule is, that his account of what the patient told him is not evidence in the eye of the law, unless it was told under the consciousness of the approach of death. Of late, however, the rigor of this principle in law has been occasionally departed from in Scottish practice; and in regard to medical facts ascertained in the way here mentioned, many strong reasons might be assigned for such relaxation. Evidence of the kind is technically called the death-bed declaration of the deceased, and is justly accounted very important.

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tion. But at the time the surgeon made his inquiries, he did not even suspect that the girl laboured under the effects of poison. Neither he therefore nor his patient could have been impressed with that conviction of the importance of the information communicated, which was necessary to insure its accuracy, particularly as it related to a point usually of so little consequence in ordinary medical practice as the precise date of the commencement of an illness; and it would consequently have been rash to adopt it in face of more direct and contrary evidence. Any one who examines the details of this trial as I have reported them, will at once see how much the case turned on the point now alluded to *.

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* Edin. Med. and Surg. Journal, xxvii. 441. The reader will remember that what was considered defective in the proof in this trial, the connexion between the administration of a suspicious article and the first invasion of the symptoms, would now appear less so, for the reason assigned in note *, p. 80.

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may be here given as an example. An elderly lady, who had certain expectancies on the death of a relation, conceived that the family of her relative had resolved to defraud her of her supposed rights. She afterwards imagined that an attempt was made to poison her, and camphor was the poison she fixed on as the article which had been administered. In its general or moral particulars the narrative was all plausible and suspicious enough; but unluckily for its consistency, she stated that the poison could only have been given in wine,—that she did not remark any particular taste in the wine,—that her illness did not begin till the day after she took it; and although she alleged, without any leading question on my part, that camphrous perspiration was exhaled on the subsequent day, the whole train of the symptoms differed entirely in every other respect from a case of poisoning, and resembled closely in their origin and progress a case of slight general fever. The incompatibility of her story with the idea of poisoning with camphor will be readily understood by referring to what is afterwards said of the effects of that substance.

Feigned or *Pretended Poisoning* will be much more apt to escape suspicion, and when suspected is commonly more difficult to develope satisfactorily; for the actor has it in his power to lay his plans with care, and even to become acquainted with the properties of the poison whose effects he intends to feign. Still he can rarely enact his part so well as to deceive a skilful physician both by existing symptoms and by his history of their origin and progress; much less can he contrive his scheme so adroitly that it shall not be unfolded by the refinements of chemical analysis.

The investigation of such a case will be directed of course in the first instance to the state and progress of the symptoms. Here, as in imaginary poisoning, it is of moment to conceal from the individual the suspicion entertained of his falsehood. For even if a person who has actually taken poison knows he is unjustly suspected of feigning, it is not improbable that he might try to mend his story with impossibilities, and so lead the physician into error. In a case of feigned poisoning an excellent mode of investigation is, after hearing out the individual's own story, to put a number of questions involving an alternative answer, one alternative being compatible and the other incom-

patible with the alleged natu
al person can stand such a sy
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In the next place, great
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years ago in a London paper
nic, where the dregs of a bo
but finely pounded glass. So
son contained in the remain
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matter, even the matter fi
of the alleged poison. So
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analysis which are not anim
in the stomach. Sometimes
in such matter may be great
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The following example w
laid down. A young marri
pregnancy, having been disc
ly addicted to dram-drinkin
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represented that she had tak
struction, that she was in g
she must soon die. It was
a neighbouring apothecary,
chased about a drachm and
purpose of poisoning rats;

which she said she mixed it, there was left a small quantity of white powder, that proved on analysis to be pure oxide of arsenic. Notwithstanding these strong facts, the mildness of the symptoms and the composure with which she complained of her tortures led her friends to suspect she was feigning. On investigating her case I first ascertained, in farther corroboration of her story, that the powder was nowhere to be found. But she then stated in reply to questions involving an alternative answer, that the arsenic had a sour taste, and that the pain began in the lower part of the belly and spread upwards. She likewise said that she vomited a mouthful or two into a chamber-pot twenty minutes after taking the poison, that she vomited no more till the apothecary was sent for who gave her emetics of sulphate of zinc, carefully preserving the discharges, and that she only vomited when emetics were given. When I first saw her, five hours after the alleged date of the taking of the arsenic, the skin was warm and moist, the face full and flushed, the pulse frequent and firm, the muscular strength natural. The chamber-pot contained only a small quantity of the fæces of a child and apparently a little water, but no vomited matters, and no white powder. The fluid discharged in presence of the apothecary was found on careful analysis to contain a large quantity of zinc, but not an atom of arsenic. She gradually recovered from the illness under which she laboured at the time I saw her, and in two days she admitted she was quite well, but continued to insist that she had taken the poison.—*M. Tartra* has related a singular case of the same kind, where a young woman feigned poisoning with nitric acid, and was not detected for several days *.

Imputed Poisoning differs in general from feigned poisoning only in so far as the symptoms which are feigned are imputed to the agency of another.

The imputation of the crime of poisoning by feigning or actually producing the symptoms and contriving that poison shall be detected in the quarters where in actual cases it is usually sought for, has been not unfrequently attempted. Two important continental cases have already been referred to for other purposes, [pp. 67, 78]; and I may here relate the heads of two English cases, which are of great interest, and will serve to illustrate the mode of procedure in such circumstances.

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* Sur l'Empoisonnement par l'acide nitrique, p. 243.

The first of these, which I
is a striking example of th
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medical gentleman who con

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The only other case of w
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Traill, who was consulted b

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* Edinburgh Medical

of Liverpool. A man accused his sister-in-law of administering poison in his tea. He stated that he was seized with pain in the stomach and uneasiness in the head half an hour after taking the tea; and when visited soon after, the countenance was anxious, the skin pallid, the pulse frequent, the throat red; and while Mr Parr was examining the throat, a quantity of matter was vomited, containing a white, gritty, crystalline substance, which was afterwards ascertained to be oxalic acid. The following circumstances, however, proved that the poison could not have been given in the tea. The man alleged that he remarked in the very first mouthful an acrid taste, followed by sweetness, which is not the taste of oxalic acid. Notwithstanding this warning, he drank the greater part of the tea. He stated that the poison was dissolved in the tea, yet he vomited some oxalic acid in the solid form. Granting he was mistaken in supposing the whole poison dissolved, the quantity swallowed must in that case have been large; and nevertheless the symptoms were mild, though no vomiting took place for about an hour, and next day he was almost well. Four other individuals had tea at the same time from the same tea-pot, without sustaining any harm; and what remained of the infusion did not contain any oxalic acid. Finally, his niece took what he left of his tea in the basin, without remarking any thing unusual in the taste; and in the unwashed basin not a trace of oxalic acid could be detected. It was quite plain, therefore, that the man's accusation was false; and certain points of general evidence, coupled with the medical facts, proved that he must have taken the oxalic acid himself.

It has been alleged, that attempts have been made to impute the crime of poisoning by introducing poisonous substances into the body after death; and although I have not been able to find any actual instance of such ingenious atrocity mentioned by authors, it must be acknowledged to be quite possible; and the medical jurist should therefore be prepared for the requisite investigations. Every case may be clearly made out by attending to the relative effects of poisons on the dead and on the living tissues;—a subject which will receive some notice under the head of the principal poisons in common use.

PART S

OF INDIVIDU

CHAP

OF THE CLASSIFICA

AFTER the preliminary observ
proceed next to treat of Poison
remarks will be confined in a g
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ing mere objects of curiosity,
either intentionally or by accide
out their leading properties.

The Classification of Poison
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animal economy; for such a clas
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ced in consequence of that actio
ed, that no system founded on ei
be logically correct, or constitu

would be very desirable, if their mode of action could be adopted as the basis of arrangement; but both reasoning and experience have proved this to be impracticable. One very distinct class indeed might be formed of purely Local poisons, comprehending the mineral acids, the fixed alkalies, and one or two of their chemical compounds. But then, a vast proportion of the other poisons which act locally have also a general or remote action; and on the other hand, there are few of the latter description which do not likewise act locally. Hence if all those which possess this double action were arranged in one class, the class would include nine-tenths at least of known poisons;—so that in truth, the labour of classification would still remain to be overcome. An attempt to form a classification of this kind has been made by a distinguished author, *Dr Paris.* His proposed toxicological system will be seen in his work on Pharmacology, and likewise in that more recently published on Medical Jurisprudence. The system he proposes can hardly be made practically available; and the author himself seems sensible of its inadequacy, as he has not followed it in any of his writings.

It would be equally or even more fruitless to attempt an arrangement of poisons according to their medium of action; for no sure and ready criterion is known, by which in any given case a poison acting by direct transmission of an impulse along the nerves can be distinguished from one that acts by previously entering the blood.

Neither is the embarrassment of the toxicologist materially less, if he attempts to classify poisons according to the symptoms they induce in man. This is the principle now generally followed, and that which in common with others I shall pursue. But the reader will be at no loss to discover that the partitions which separate the classes from each other are exceedingly slight, and that a vast number of the individual poisons might be arranged without impropriety in either of two classes.

The preceding statements will be sufficient to prove that it is impossible to found a good system of arrangement on the only basis which can be acknowledged philosophical and practically useful; and consequently, that, as the science of toxicology now stands, we must altogether despair of forming one that shall be even moderately satisfactory.

Upon the whole, the best wh
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Course of Legal Medicine publ
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The class of Irritants should
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must be admitted, nevertheless
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The class of Irritant poisons c
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CHAPTER II.

CLASS FIRST.

ON IRRITANT POISONS GENERALLY.

Under this head I shall introduce the subject of the irritant poisons by relating their general symptoms and morbid appearances, and contrasting these with the symptoms and morbid appearances of the natural diseases which are chiefly liable to be confounded with irritant poisoning, or mistaken for it.

Section 1.—*Of the Symptoms of the Irritant Class of Poisons, compared with the symptoms of various natural diseases.*

The symptoms caused by the irritating poisons, when taken internally, are those of violent irritation and inflammation of one or more divisions of the alimentary canal.

The mouth is frequently affected, especially when the poison is easily soluble, and when it possesses a corrosive as well as irritating power. The symptoms referrible to the mouth are pricking or burning of the tongue, redness, swelling and ulceration both of the tongue and of the palate and lining membrane of the cheeks.

The throat and gullet are still more frequently affected; and the affection is for the most part burning pain, sometimes accompanied with constriction and difficulty in swallowing, and always with redness of that part of the throat and gullet which is visible. The affection of the throat and mouth precedes every other symptom when the poison is an active corrosive, and more particularly when it is either a fluid poison or is easily dissolved. Nay sometimes burning pain of the mouth, throat, and gullet occurs during the very act of swallowing. On the contrary if the poison is soluble with difficulty, and is only an irritant, not a corrosive, and still more if it is only one of the feebler irritants, the throat is frequently not affected sooner than the stomach, occasionally not at all.

The stomach is the organ which suffers most invariably from the operation of the irritant poisons. The symptoms referrible

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and in particular the intestines.

The action of the irritant poi
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much swelling, but frequently v
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mucous coat of the intestines is
of the anus and prolapsus of th
red colour. The pain of the bo
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often also streaked with blood or
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no other part of the alimentary
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are affected together.

In a few very aggravated ca
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The symptoms now briefly e

almost every instance with great disturbance of the circulation —quick, feeble pulse—excessive prostration of strength,—coldness, and clammy moisture of the skin.

The other symptoms, which are often united with the preceding, do not belong to the Irritants as a class. Perhaps, however, among the symptoms of the Class may be mentioned those of irritation and inflammation of the windpipe and lungs, and those of irritation in the urinary organs. A great number of the Irritant poisons cause hoarseness, wheezing respiration, and other signs which indicate the spreading of the inflammation of the throat to the windpipe; some likewise cause darting pains throughout the chest: and not a few are very apt to cause strangury and other signs of inflammation of the urinary passages.

Of the effects of the irritants when they are applied externally little need be said at present. Their most striking external symptoms will be noticed under the head of one of the orders of this class, the Vegetable Acrids. In the Chapter on the Local action of poisons some account was given of the several effects which are produced by the application of poisons to the skin. It is there stated that some produce merely redness, that others cause blistering, that others bring out a crop of deep-seated pustules, that others corrode the tissues chemically, and so give origin to a deep slough, and that others excite spreading inflammation of the cellular tissue under the skin and between the muscles.

Such is a general view of the symptoms caused by the irritant poisons. This topic will be afterwards taken up in detail under the head of the several species. At present an important subject remains for consideration, namely, the natural diseases whose effects are apt to be mistaken for the effects of poison. The remarks now to be made might be extended to many diseases. In fact, they might be extended to all diseases which prove fatal suddenly, for all such diseases are apt in peculiar circumstances to give rise to a suspicion of poisoning. But those only will be here noticed which occasion the greatest embarrassment to the medical jurist, and which are most likely to come under his review in courts of law. They are the following—Distension and rupture of the stomach; rupture of the duodenum, biliary ducts, uterus, or other organs in the belly; the effects of drink-

ing cold water; bilious vomitin
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the intestines; inflammation of
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1. *Distension of the Stomach.*—
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There is reason, however, to su
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teen minutes after dinner; and as
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guish, called out for fresh air, e
actually expired before his physic
for, could arive. Wildberg foun

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* Dictionnaire des Sciences Médicale

distended with ham, pickles, and cabbage-soup, that, when the belly was laid open, nothing could be seen at first but the stomach and colon. Some white powder was found on the villous coat of the stomach, and it was at first suspected to be arsenic; but it proved on analysis to be merely magnesia, which the gentleman had been in the habit of taking frequently. The diaphragm was pushed high into the chest by the distended stomach. There was not any particular congestion in the brain. Wildberg very properly ascribed death to simple over-distension of the stomach*.—In all such cases the symptoms may be suspicious; but when carefully considered they can hardly be said to resemble closely the effects of irritant poisoning; and at all events the appearances in the dead body will at once distinguish them.

2. *Rupture of the Stomach* is not a common occurrence; but it sometimes imitates closely in its symptoms the effects of the irritant poisons.

It is generally the consequence of over-distension, combined with efforts to vomit. On account of the abrupt turn which the gullet makes in entering an excessively distended stomach, the cardia or opening of the gullet into the stomach becomes valved, and the contents cannot be discharged by vomiting. A striking case of this kind is related by *M. Lallemand* in his Inaugural Dissertation at Paris in 1818†. A woman convalescent from a long attack of dyspepsia, being desirous to make amends for her long privations as to diet, ate one day to satiety. Ere long she was seized with a sense of weight in the stomach, nausea, and fruitless efforts to vomit. Then she all at once uttered a piercing shriek, and exclaimed that she felt her stomach tearing open; afterwards she ceased to make efforts to vomit, soon became insensible, and in the course of the night she expired. In the fore part of the stomach there was a laceration five inches long; and a great deal of half-digested food had escaped into the cavity of the abdomen. The coats of the body of the stomach were healthy; but the pylorus or opening into the intestines was indurated; which had been the cause of her dyspepsia.

In other cases of death from rupture the laceration is caused

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* Praktisches Handbuch für Physiker, iii. 292.

† See also Dictionnaire des Sciences Médicales, *Art.* Rupture, xlix. 225.

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French Journal. A child, a t
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In other cases, however, it
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* Medicina Legale, ii. 22.
† Archives Générales de Médecine
‡ *Mr Weekes,* in London Medico-
§ London Medical and Physical J

mas feast, at which he ate and drank heartily, was attacked with violent and frequent vomiting. Next morning he said he felt as if the blood in his heart was boiling, he was unable to swallow, the pulse became irregular, and pressure on the heart or stomach gave him excruciating agony. These symptoms continued till the following day, when he vomited two pounds of blood at successive intervals, and soon afterwards expired. The inner coat of the stomach was torn in many places, and that of the duodenum was lacerated almost completely round. No other disease existed either in the bowels or elsewhere[*].

Some of the cases now mentioned could hardly be distinguished from the effects of certain irritant poisons by the symptoms only. But the morbid appearances in the stomach will at once determine their real nature.

Rupture of the stomach, it should be observed, does not always occasion the symptoms hitherto related. Sometimes it causes instant death. Thus a healthy coal-heaver in London, while attempting to raise a heavy weight, suddenly cried out, clapped his hand over his stomach, drew two deep sighs, and died on the spot. On dissection a lacerated hole was found in the stomach, big enough to admit the thumb; and the stomach did not contain any food[†]. This case, along with those of Dr Roberts and Mr Weekes, will show that rupture may take place without previous distension.

3. *Rupture of the duodenum* is a very rare accident from internal causes. The following instance resembles considerably the symptoms of irritant poisoning. A gentleman, 48 years old, quarrelled violently with another while playing billiards immediately after dinner. Soon afterwards he was seized suddenly with violent pain in the stomach, vomiting, cold extremities, failing pulse, and he died very soon. The mucous coat of the duodenum was found much inflamed, and four inches and a-half from the pylorus there was a lacerated hole involving a third of the circumference of the gut[‡].

4. Under the next head may be classed rupture of the other organs of the belly. *Rupture of the Biliary ducts* for example, an extremely rare accident, has been known to imitate closely

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[*] London Medico-Chirurgical Transactions, v. 93.

[†] London Medical Repository, xvii. 108.

[‡] Bulletins des Sciences Médicales, x. 64.

the symptoms of irritant poison
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5. The next accident which
being liable to be mistaken for
death from Drinking cold Water

In Britain the most common

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* Journal des Progrès de

appears to have been instant death, arising from the impression on the stomach. It is not an uncommon thing for people to drop down instantaneously and die on the spot, in consequence of drinking freely of cold water or other fluids while overheated[*]. There is an interesting report on a case of this kind by *Pyl* in his Memoirs and Observations. The individual had been quarrelling with a companion, and in the height of a fit of violent passion swallowed a glass of beer; when he dropped down senseless and motionless, and died immediately. His wife suspecting the administration of poison, demanded a judicial inquiry; but nothing was found in the body to account for death. Pyl therefore came to the conclusion that the man died from the sudden impression caused by the cold beer [†].

But when combined with exposure to a burning sun, as in hot climates, drinking cold water when the body is overheated seems often to excite along with irritation in the stomach congestive apoplexy. *Dr Watts* has given a good account of these effects as they occurred in the neighbourhood of New York during the hot season of 1818. During the summer of that year the thermometer often stood in the shade so high as 92°; and the labourers in consequence could not be restrained from drinking frequently and excessively of cold water. Many were attacked with pain in the stomach, sickness, giddiness, and fainting; next with difficult breathing, and rattling in the throat; then with apoplexy; and not a few perished [‡]. These symptoms are very like the effects of some narcotico-acrid poisons.

Lastly, drinking cold water sometimes causes symptoms more nearly allied to those of the pure irritants. Thus some persons, on eating ices, or drinking iced-water, or cold ginger-beer in the hot days of summer, are attacked with violent colic. *Haller* has even mentioned an instance of a man, who, after swallowing a large draught of cold water while over-heated, was seized with symptoms of acute gastritis, and died in fifteen days; and in the dead body the stomach was found gangrenous and ulcerated at its fundus [§]. Cholera has also been sometimes referred to the same cause. In the hot summer of 1825 it was

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[*] For an instance, see Bulletins des Sciences Médicales, ix. 249.

[†] Aufsätze und Beobachtungen aus der gerichtlichen Arzneiwissenschaft, v. 89.

[‡] New-York Medical Register.

[§] *Abercrombie* on Diseases of the Stomach, &c. 14.

remarked, that a great number
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It is unnecessary to give her

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[*] Bulletins des Sciences Médicales,

[†] De cauta et circumspecta veneni d

toms of simple cholera. There is the same burning pain in the stomach and bowels as in irritant poisoning, the same incessant vomiting and frequent purging, the same tension and tenderness of the belly, the same sense of acridity in the throat, and irritation in the anus, the same depression and anxiety, the same state of the pulse.

It would be wrong, however, to infer from these resemblances that the two affections are always undistinguishable. Some cases of irritant poisoning certainly cannot be distinguished by their symptoms from cholera. Other cases are similarly circumstanced, because their particulars cannot be accurately collected. But there is no doubt that in many others the distinction between poisoning and cholera may be drawn by the physician who has been able to ascertain the symptoms in detail. At present those points of difference only will be noticed which relate to the irritants as a class; others will be mentioned under the head of the poisons individually.

The first difference is, that in cholera the sense of acridity in the throat does not, as sometimes happens in poisoning, precede the vomiting. In cholera this sensation is caused by the vomited matters irritating the throat, or perhaps by the irritation in the stomach being propagated upwards by continuity of surface. But, however the fact may be in respect to its cause, it is certain that the sense of acridity or burning sometimes remarked in cholera never begins before the vomiting. In many cases of poisoning, though certainly not in all, it is the first symptom.—The next difference is, that in cholera the vomiting is never bloody. I have been at some pains to investigate this point; and I have been unable to find any instance of the cholera of this country, which has been accompanied with sanguinolent vomiting; neither is such a symptom mentioned in any accounts I have read of malignant cholera. This article of diagnosis will, of course, be open to correction from the experience of other practitioners.—Lastly, a material difference is, that the simple cholera of this country very seldom proves fatal so rapidly as poisoning with the irritants usually does. Death from irritant poisoning is on the whole seldom delayed beyond two days and a-half, and frequently happens within thirty-six hours, sometimes within twelve hours, or even less. Malignant cholera

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fact, that many practitioners of
single instance, and others wit
a long practice. *Dr Duncan Se*
only one of the kind he had m
after the individual ate a sour o
and which proved fatal in twelv
met with a single case, which
of cholera produced by drinkin
also once, and once only, met w
Mr Tatham, a late writer on th
which proved fatal in twelve h
has likewise related an instanc
occurring in a child [‡]. And I
at Leith which ended fatally i
first supposed by the unprofess
be an instance of epidemic or ma
Drs Home, *Alison*, and *Graham*,
in so short a time as two or t
Medico-Chirurgical Society o
present could remember to ha
witnesses who were brought t
known trial, all of them physi
one could depose that such a ca
sonal observation [‖]. I think
the reader will refer to a cont
long ago by *Dr Mackintosh* of
by that gentleman, that he has

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[*] Edinburgh Medical and Surgical J
[†] Ibidem, xxix. 70.
[‡] London Medical Gazette, viii. 496
[§] Edinburgh Medical and Surgical J
[‖] Trial of Donnal.—See *Paris* and
Appendix, 277, *et seq.*

period now mentioned [*]. Every one will be able to judge for himself from the facts here mentioned. For my own part, I cannot help repeating as the result of the whole inquiry, that simple cholera rarely causes death in this country in the period within which irritant poisoning commonly proves fatal,—that, consequently, every case of the kind will very naturally and justly be apt to lead, in peculiar circumstances, to suspicion of poisoning,—and that in charges of poisoning, rapid death under symptoms of violent irritation in the alimentary canal, like those of cholera, must always be considered an important article of a chain of circumstantial or presumptive evidence.

7. *Of Malignant Cholera.* In former editions of this work malignant cholera was not included in the list of diseases which imitate irritant poisoning, because the disease was unknown at the time in Europe; and the history of the epidemic affords a fair promise that, in so far as British practitioners are concerned, the same reason for omitting it may soon again stand good. Meanwhile, however, malignant cholera must be allowed to bear, in its essential symptoms and their course, a marked resemblance to poisoning with the irritants. So much indeed is this the case that some authors on the late epidemic have actually compared its phenomena to the effects of arsenic, tartar-emetic, and other powerful acrids. In many cases the two affections are undoubtedly almost undistinguishable by symptoms, at all events not sufficiently distinguishable to warrant a physician to rely on the diagnosis in a medico-legal inquiry. But in many other instances I apprehend the distinction may be drawn satisfactorily. Thus the uneasiness in the throat which sometimes attends cholera never precedes the vomiting. The vomiting in cholera is never bloody. The colour and expression of the countenance and whole body are peculiar. In frequent instances the early signs which resemble poisoning are followed by a secondary stage, sometimes of simple coma, sometimes of typhoid fever, which a practised person may easily distinguish from the secondary phenomena which are produced by some irritants. Lastly, no mistake can arise where the patient before presenting the symptoms common to both affections, experiences violent burning pain or certain tastes, during or immediately after the swallowing of food, drink, or some other article.

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[*] Edinburgh Medical and Surgical Journal, xxviii. 87.

8. *Of Inflammation of the Sto*
the stomach is a common enoug
account of the slowness of its c
founded with the ordinary effects
inflammation, on the contrary, fol
as that of irritant poisoning. B
tained whether true acute gastrit
as a natural disease. Several of
long been in extensive practice,
experience coïncides entirely wit
observes he has " never seen a
as being of that nature [*]." An
same purport has been made by
perienced and accurate pathologi
says that during six years' service
during which he noted the partic
dissections, he did not meet with
mary gastritis. The disease onl
fection, or complicating some
cause of death [†]. So far as I
quire among systematic authors,
acute gastritis appear to have be
caused by poison.

The following are the only spe
met with of an affection of the n
tritis; and the reader will be at n
of them it admits of being viewed
ler's case of inflammation and ga
cold water incautiously [p. 108].
incident related by *Lecat*, and occ
teen years old, was attacked whil
ing, faintness, acute pain in the
imperceptible pulse; and she di
stomach was found red, and chec
and gangrenous pustules, (probabl
yet it was supposed to have been
taken any thing deleterious [‡]. T

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[*] On Diseases of the Stomach and other

[†] Recherches sur la Gastro-entérite, ii. 5

[‡] *Lainé* sur les Perforations Spontanées,

appearance pointed. But when it is added, that the girl's mother was attacked about the same time with precisely the same symptoms and died in four hours, I think the reader, when he also considers the imperfect mode in which chemical inquiries were then conducted, will by no means rest satisfied with Lecat's assurance that nothing deleterious was swallowed. The last is an equally singular case given by *Dr Hastings* of Worcester, where poisoning with cantharides was suspected. A young lady, liable to indigestion, but at the moment in better health than usual, was attacked with sickness before breakfast and after it with vomiting. Three days elapsed before she was seen by her medical attendant, who found her sinking under incessant vomiting, severe pain in the loins, strangury, bloody urine, and swelling of the clitoris, attended with red extravasation of the eyes, and a red efflorescence on the skin. Death followed next day amidst convulsions; and there was found in the dead body extravasation of blood between the kidneys and their outer membrane, into the pelvis of each kidney, and into the bladder,—redness of the bronchial membrane, and gorging of the air-cells with blood,—and general redness of the inside of the stomach, with numerous extravasated spots in the submucous coat*. It seems to have been clearly proved at the coroner's inquest that poisoning was here out of the question. But the case appears rather to have been one of renal irritation or inflammation than of gastritis, and the affection of the stomach secondary merely.

The question as to the possibility of acute gastritis being produced by natural causes is one of very great interest to the medical jurist. For its possible occurrence is the only obstacle in the way of a decision in favour of poisoning, from symptoms and morbid appearances only, in certain cases by no means uncommon, which are characterized by signs of violent irritation during life, early death, and unequivocal marks of great irritation in the dead body, namely bright redness, ulcers, and black, granular, warty extravasation. In regard to these effects, it may with perfect safety be said, that they can very rarely indeed all

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des Hopitaux Militaires, i. 375.—This case is also given by *MM. Petit and Serres* in their treatise entitled " de la Fièvre Entéro-Mésentérique," p. 197, and is considered by them an instance of that particular disease.

* Trans. of Provinc. Med. and Surg. Association, vol. i.

arise from natural causes; and f
subject is investigated the more
ever arise in this country from
The possible occurrence of a case
must be granted. But this conc
from the importance of the conti
lars of a chain of circumstantial

In whatever way the fact as to t
gastritis may eventually be prove
rion of this disease, as of cholera, w
in the throat, if present at all, do

9. *Inflammation of the Intestine*
mon than inflammation of the sto
is generally accompanied, howev
bowels. Acute enteritis, unless
gists to consider cholera as of that
ed with purging.

There is a variety of intestinal i
ed to briefly in the chapter on the
soning, and which bears a close re
irritants. It is a particular variet
tuated near the end of the small in
with trifling or insidious symptom
in perforation of the gut. It begin
ing of the mucous membrane in
ulcer appears on the middle of on
gradually spreads over them, and at
other coats. At last, when the
some trifling accident ruptures it,
the sac of the peritonæum, and th
in the course of one or two days,
cases, if not distinguished by the s
cognized by the morbid appearanc
tines with similar symptoms also t
vious tuberculation described abov
coats †.

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* *Louis.* Archives Générales de Médeci
Journal, xxi. 239, also *Abercrombie* on Diseas
Recherches sur la Gastro-entérite, *passim.*

† *Abercrombie* on Diseases of the Stomac

Another form of intestinal inflammation may also be here particularized, because it imitates the effects of the irritants in the cases in which they prove slowly fatal. It is a form of aphthous ulceration of the mucous membrane of the alimentary canal, which appears to affect almost every part of it from the throat downwards, and begins commonly in the throat. I once met with a remarkable case in which it appeared in the form of little white ulcers in the back of the throat, and gradually travelled downwards to the stomach and from that to the intestines,—being characterized by burning pain in every one of its seats, and successively by difficulty of swallowing, sickness, vomiting and tenderness of the stomach, and finally by purging. Such cases resemble very much the slow forms of poisoning with arsenic. But they differ in attacking the several divisions of the alimentary canal in turn, while in the examples of poisoning with arsenic now alluded to the whole canal from the mouth to the anus is affected simultaneously. *Dr Abercrombie* has described a similar disorder, which he appears to have occasionally seen affecting both the stomach and intestines at the same time; but he seems to doubt whether it ever occurs as an idiopathic disease, or independently of some co-existing or preceding fever or local inflammation *.

10. *Inflammation of the Peritonæum*, or lining membrane of the belly, will not require many remarks. When acute, it is rarely attended in its early stage by vomiting; rarely also by irregular action of the intestines, and never by diarrhœa; and it is at once distinguished in the dead body by unequivocal marks of peritonæal inflammation, which are very seldom caused by irritant poisons †.

11. The subject of *Spontaneous Perforation of the Stomach* is an important topic for the medical jurist, because both the symptoms before death and the appearances in the dead body are occasionally very like the effects of some of the most active irritant poisons. The following is a statement of the most material facts hitherto ascertained on this subject; but it must be premised that a good deal of obscurity hangs over some parts of it.

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* *Abercrombie* on Diseases of the Stomach, &c. p. 52.

† For cases of this disease see *Abercrombie* on Diseases of the Stomach, &c. p. 156 and 181.

Spontaneous perforation of th
One is the last stage of some vari
rated membrane ulcerates, the ulc
then the muscular coat; at last t
also gives way, and the contents o
belly. The symptoms of the perf
thing giving way in the pit of the
ally extending over the whole abd
tension, excessive prostration, an
twenty-four hours. The sympton
ration are in general such as clearl
ment of the stomach, namely aggrav
ing. Several cases of this descript
by *M. Laisné*[*], a pupil of Profess
racteristic cases have also been pu
but sometimes no symptom exists
in a case related by *Dr Kelly* of a
was suddenly seized with excruciati
expired in eighteen hours, and in w
found perforated in the middle of a
induration of the villous coat [‡].

The second variety of perforatio
ceration without previous scirrhus.
papers will be found some remarks
a case of this kind. The subject of
habit, who enjoyed good health, till
suddenly attacked with acute pain
and died in thirteen hours. The st
ed; and the perforation was in the
of the mucous coat, including in it
ring of the pylorus [§]. This case sho
of perforation may take place witho
disease being indicated by any sym

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[*] Considérations Medico-légales sur les pe
1819. This thesis is published with three othe
understood to have been in a great measure the
sier.

[†] Trans. of the Dublin College of Physici
rurgical Transactions, viii. 228.

[‡] *Abercrombie* on Diseases of the Stomach,

[§] London Medico-Chirurg. Transactions, v under which it commenced are peculiarly important in relation to the medical jurisprudence of poisoning. Another case which has been lately described with great exactness by *M. Duparcque*, was preceded only by very trivial dyspeptic symptoms. Here the whole mischief arose from a small ulcer eight lines long and five in breadth on the inside of the stomach, and not more than a line and a half in diameter at the perforation through the peritonæum [*]. Several excellent examples of the same disease have been related by *Dr Abercrombie* [†]. In one of these the ulcer, in the centre of which the perforation had been formed, was not bigger than a shilling, and the rest of the stomach quite healthy.—In some cases, as in that of M. Duparcque, the pain at the moment the perforation is completed is not at first very violent, because the close proximity of some adjoining organ, such as the liver, prevents the contents of the stomach from escaping for a time, so that inflammation of the peritonæum is but gradually developed.

The third variety of spontaneous perforation is of a much more singular kind. It is produced not by ordinary ulceration, but by a species of softening or gelatinization of the coats. The gelatinization sometimes extends over a considerable extent of surface, affecting chiefly the villous coat, so that the perforation through the other membranes is surrounded by an extensive pulpiness of the internal membrane. It is not necessarily, and indeed is seldom actually accompanied by vascularity. Its symptoms are exceedingly obscure. In adults there is very rarely any symptom at all till the perforation is complete; in children, as appears from a paper by *Dr J. Gairdner* of this city [‡], and another by *Dr Pitschaft*, a German author [§], the early symptoms indicate an obscure chronic gastritis. The nature of this singular disease will be mentioned in the section on the morbid appearances. At present it may merely be observed, that the injury caused to the coats of the stomach seems to be precisely the same with the gelatinization, which is sometimes found after death in persons who had no symptoms of an

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[*] Archives Générales de Médecine, xxvi. 123.

[†] On Diseases of the Stomach, pp. 35, 37.

[‡] Edinburgh Medico-Chirurgical Transactions, i. 311.

[§] *Rust's* Magazin für die gesammte Heilkunde, xxi. 199. This paper is analyzed in Edinburgh Med. and Surg. Journal, xxvi. 451.

affection of the stomach, and whic
and most British pathologists, to
tric juice in the dead body. Th
is given by *Laisné* in his Thesis
ing is a good example: A young l
was awakened at three one morn
the stomach, which nothing could
hours after; and on dissection twc
part of the stomach, surrounded w
lous coat †. Another case will be
appearances produced by this dis
have been mistaken for the effect

12. The *Gullet* may be perforat
with or without symptoms. Unde
pearances [135] two instances will
were no corresponding symptoms.
toms did pre-exist. A man, six w
which was killed without its state of
ed, was attacked with a sense of stra
lowing, delirium, excessive irrital
he died within twenty-four hours.
the diaphragm, was perforated by
in diameter, with thin edges, and
into the posterior mediastinum. ‡

13. *Perforation of the Alimentar*
also be noticed shortly as a disease
be confounded with irritant poisoni
a common accident, and very rarel
most of the cases in which it has b
antecedent to death were those not
poisoning, and were then owing s
lation of worms in the alimentary
reader is referred to the article E
remarks on the effects of the Narc
at times the symptoms have been li
ing. Thus the following is a case o
ring life giving rise to all the phenc

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* Philosophical Transactions, lxii. 447.

† *Gastellier* in Leroux's Journal de Médeci

‡ Archives Générales de Médecine, xi. 463

ritoneal inflammation. A soldier at Mauritius was seized with slight general fever and severe pain, at first in the pit of the stomach, and afterwards over the whole belly, which on the third day began to enlarge. A tendency to suppression of urine and costiveness ensued, then bilious vomiting; and he died on the fourth day, the belly having continued to increase to the end. On dissection, several quarts of muddy fluid were found in the sac of the peritonæum, the viscera were agglutinated by lymph, a round worm was discovered among the intestines between the navel and pubes, and the ileum was perforated six inches from the colon by a hole corresponding in size with the worm*.—A singular case, not however fatal, but which confirms the fact, that worms may make their way through the intestines and other textures during life, is mentioned in *Rust's* Journal. A woman after a tedious illness first vomited several lumbrici, and was then seized with a painful swelling in the left side, which in the process of time suppurated, and discharged along with the purulent matter three other worms of the same species†. Another instance of the same kind, where the perforation of the gut succeeded strangulated hernia, and was followed by the discharge of two lumbrici and ultimate recovery, is detailed in the Revue Médicale‡.

14. The next diseases to be mentioned are *Melæna* and *Hæmatemesis*, or purging and vomiting of pure or of altered blood.

It is hardly possible to mistake them for poisoning, as the pain which accompanies them is seldom acute, and the discharge of blood is generally profuse.

15. The last are *Colic*, *Iliac Passion*, and *Obstructed Intestine*. As the symptoms of some poisons are the same with those of colic, it is of course sometimes impossible to distinguish the natural disease from the effects of poison by attending to the abdominal symptoms only. But the distinction in severe cases of poisoning may almost always be drawn from collateral symptoms and extraneous circumstances.—The Iliac Passion is distinguished by a complete reversion of the vermicular motion of the intestines, in consequence of which the fæces are often discharged by vomiting. I am not aware that stercoraceous vo-

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* *Mr Kell* in London Medical Gazette, ii. 649.

† Magazin für die gesammte Heilkunde, xviii. 107.

‡ Revue Médicale, 1826. i. 100.

miting is ever caused by poison in Corvisart's Journal, in which struction of the ileum by hardene ty-six hours, gave rise to a judi of poisoning*. Another instanc picion of poisoning, has been la which there was continued vomi ing fatal in two days, and arisin ing obstructed by an adventitio inspectors failed to observe the of the symptoms; but Rostan a to examine the body a second ti and were unable to find any poi Stercoraceous vomiting occurre been held sufficient to settle the r tion of the intestines arising fro ception, foreign bodies, or stran by the seat where the pain begin and also by the excessive enlarg however, is rather an equivocal

The preceding observations determine how far a diagnosis toms, between poisoning with which resemble it. It will be rassing disease, on account of it toms, is cholera. Cholera, howe instances even considered in re and we shall presently find tha better from the effects of some

SECTION II. — *Of the morbid Poisons, compared with thos*

The next subject for conside produced by the irritants as a similar nature, which arise fro

The powerful irritants, whi simply the appearances characte mentary canal in its various sta gullet vascularity, and also, if the case has lasted long enough, ulceration;—in the stomach, vascularity, extravasation of blood under and in the substance of the villous coat and likewise into the cavity of the organ, abundant secretion of tough mucus, deposition of coagulable lymph in a fine net-work, ulceration of the villous or even of the other coats, occasionally perforation, preternatural softness of the whole or of part of the villous coat, and on the other hand sometimes uncommon hardness and shrivelling of that coat; in the intestines vascularity, extravasation, and ulceration.—Sometimes several of these appearances are to be seen in the whole alimentary canal at once. In poisoning with arsenic or corrosive sublimate it is no unusual thing to meet with redness or ulceration of the throat, great disease in the stomach, vascularity of the small intestines, ulcers in the great intestines, excoriation of the anus.—When the poison is an active corrosive much more extensive ravages are sometimes caused, particularly in the stomach. After poisoning by the mineral acids, for example, the whole mucous membrane of the stomach is at times found wanting; nay, large patches of the whole coats may be wanting, and the deficiency supplied by the adhesion of the margin of the aperture to the adjoining viscera, and the conversion of the outer membrane of these viscera into an inner membrane for the stomach.

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* Journal de Médecine, xxxiv. 25.

† Affaire Hullin. Archives Générale

Of the appearances here briefly enumerated the particulars will be related partly under what is now to be said of the appearances arising from natural causes, which are liable to be confounded with the effects of poisons, partly under the head of individual poisons.

Of redness of the stomach and intestines from natural causes, and its distinction from the redness caused by poisons.

Simple redness of the alimentary mucous membrane in all its forms, whether of mere vascularity, or actual extravasation, not only does not distinguish poisoning from inflammatory disorders of natural origin, but will even seldom distinguish the effects of poison from those of processes that occur independently of disease, and subsequent to death. On the subject of real inflammation, as distinguished from redness originating after death, or pseudo-morbid redness as it is commonly termed,—a subject of very great consequence to the medical jurist,—

much interesting information m
lished some years ago by *Dr*
the attention of pathologists
ty of distinguishing these app
plete information is to be seen
Trousseau†, and in the elabora
former authors proved by exp
pseudo-morbid redness may be
tinguished from the parallel va
that these appearances are form
five, or eight hours after it; th
in the most depending turns of
pending parts of each turn, or
they have been formed, they m
and appear where the membra
simply altering the position o
other hand, has laid down their
and made an accurate arrangen
has divided them into Ramifor
ated, Laminated, and Diffus
hardly be explained. I must
to these excellent sources of i
count of the appearances in qu
the same time to quote an in
form of pseudo-morbid redness,
er that all other forms may eq
Among the examples, then, w
nated redness, or redness in pat
lard mentions the case of a m
whose body was found on the
intestine where it lay in the ri
red patch, six finger-breadths
dation, and not removable b
pelvis there was a similar patc

Although morbid and pseu
coat of the alimentary canal ca

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* London Medico-Chirurgical Trans

† Archives Générales de Médecine, C
Surgical Journal, xxviii. 149.

‡ De la Membrane Muqueuse Gastr

§ Ibid. p. 220.

another by any intrinsic character, M. Billard thinks this may be done by attending to collateral circumstances. According to his researches, redness is to be accounted inflammatory only when it occurs in parts not depending in position, or is not limited to such depending parts; when the mesenteric veins supplying the parts are not distended, nor the great abdominal veins obstructed at the time of death; when the reddened membrane is covered with much mucus, particularly with thick, tenacious, and adhering mucus; when the mucous membrane itself is opaque, so that when dissected off and stretched over the finger, the finger is not visible; when the cellular tissue which connects that membrane with the subjacent muscular coat is brittle, so that the former is easily scratched off with the nail.

Some observations may be here also made on another appearance, allied to the present groupe, but which there is strong reason to believe always indicates some violent irritation at least, if not even irritation from poison only, in the organ where it is found. It is an effusion under the villous coat of the stomach, and incorporation with its substance, of dark brownish black, or as it were charred, blood; which is thus altered either by the chemical action of the poison, or by a vital process. In many cases of poisoning with the mineral acids, oxalic acid, arsenic, corrosive sublimate, and the like, there are found on the villous coat of the stomach little knots and larger irregular patches and streaks, not of a reddish-brown, reddish-black, or violaceous hue, like pseudo-morbid redness, but dark-grayish-black, or brownish-black, like the colour of coal or melanosis, —accompanied too with elevation of the membrane, frequently with abrasion on the middle of the patches, and surrounded by vascularity. This conjunction of appearances I have never seen in the stomach, unless it had been violently irritated; and several experienced pathologists of my acquaintance agree with me in this statement. It bears a pretty close resemblance to Melanosis of the stomach *; but is distinguished by melanotic blackness being arranged in regular abruptly-defined spots, and still better by melanosis not being preceded by symptoms of irritation in the stomach.

Referring to what was already said under the head of the symp-

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* For a case of this rare and singular disease, see Edin. Medical and Surgical Journal, xxvi. 214.

toms of gastritis [113], I must again express my doubts whether the appearances now described ever arise in this country from natural disease. In the intestines they are sufficiently familiar to the physician, as arising from idiopathic enteritis, and from dysentery. But in the stomach their existence as the effect of natural disease is doubtful.

Another kind of coloration of the inner membrane of the stomach, which may be shortly alluded to, because it has actually been mistaken for the effect of irritation from poison, although by no means like it,—is staining of the membrane with a reddish, brownish, yellowish, or greenish tint, observed in bodies that have been kept some time, and produced by the proximity of the liver, spleen, or colon if it contains fæces. No unprejudiced and skilful inspector could possibly mistake this appearance for inflammation. But under the impulse of prejudice it has been considered such, and imputed to poison. On the occurrence of such stains an attempt was made by the French to ascribe to poison the death of the famous republican general Hoche. He died rather suddenly on his way from Frankfort to join his troops; and as poisoning was suspected, the body was opened in the presence of three French army-surgeons, and a French and two German physicians. The only appearance of note in the alimentary canal was two darkish spots on the villous coat of the stomach. The surgeons drew up a report which imputed his death to poison; but the physicians refused to sign it; and other medical people who were subsequently added to the commission decided with the latter*. The surgeons probably would not have been so hasty, if they had not known that the result of their complaisance would have been the levying of a heavy fine on the inhabitants.

The last kind of discoloration of the inner coat which requires mention is dyeing from the presence of coloured fluids among the contents. A remarkable instance has been recorded where redness of this nature was mistaken for inflammation, and the death of the individual in consequence ascribed at first to poison. A person long in delicate health died suddenly after taking a laxative draught; and the stomach, as well as the gullet, being found on dissection red and livid in various places, it was hastily inferred by his medical attendants, that these appearances were the effect of poison, and that the apothecary had committed some fatal error in compounding the draught. But another physician, who was acquainted with the deceased, although he did not attend him professionally, strongly suspected he had died a natural death; and happening to know he was in the practice of taking a strong infusion of the corn-poppy, inferred that the supposed signs of inflammation were merely stains arising from the habitual use of this substance. Accordingly, on making the experiment, he found that in dogs to which a similar infusion was given, appearances were produced identically the same*.

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* Kopp's Jahrbuch der Staatsarzneikunde, ii. 169.

Of the effusion of mucus and lymph as arising from natural causes.—The abundant secretion of tough mucus in the stomach is a sign of that organ having been irritated. But the effusion of lymph is much more characteristic. This may be produced by natural inflammation as well as by that excited by poisons. As arising from either cause, however, it is rare; and certainly by no means so common as would be supposed from what is said in systematic works; for tough mucus has been often mistaken for it. Reticulated lymph, adhering to the villous coat, and accompanied with corresponding reticulated redness of that coat, such as I have seen in animals poisoned with arsenic or oxalic acid, is an unequivocal sign of inflammation.

Of Idiopathic ulcers and perforation of the stomach and intestines and their distinctions from those caused by poison.—Both ulceration and perforation may be produced by natural disease. In the ulceration produced by poisons there is generally speaking nothing to distinguish it from natural ulcers; but that caused by some poisons, such as iodine, is said to be distinguished by the surrounding coloration of the membrane; and when the ulcer is caused by a poison which is not easily soluble and is in a state of powder, such as arsenic, the cavity of the ulcer is sometimes filled with the powder. Perforation is a very rare effect of the simple irritant poisons; but it is often caused by corrosives. It is imitated by two of the varieties of perforation from natural disease.

The form of natural perforation caused by a common ulcer is incapable of being distinguished, except in the instances in which it is attended with scirrhus.

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* Journal de Médecine, vii. 333. Also *Foderé*, Traité de Médecine-Légale, iv. 282.

By far the most remarkable variety, however, of spontaneous perforation in regard to the appearances in the dead body, is that which takes place, without proper inflammatory action, from simple gelatinizing of the coats. It is very apt to be mistaken, and in a celebrated trial, which will be immediately noticed, was actually mistaken for the effect of corrosive poison. A good deal of obscurity hangs over the subject, and although many pathologists have of late years turned their attention to it, its nature is not yet thoroughly understood. The following abstract comprehends an account of the characters it assumes, the circumstances under which it appears, and the prevailing opinions respecting its origin.

It may be situated on any part of the stomach, but is oftenest seen on the posterior surface. It is sometimes small, more often as big as a half-crown, frequently of the size of the palm, and occasionally so great as to involve an entire half of the stomach. Sometimes there is more than one aperture. The margin is of all shapes, commonly fringed, and almost always formed of the peritonæum, the other coats being more extensively dissolved. In one instance, however, which has been lately published, the peritonæal surface was on the contrary the most extensively destroyed*; and in a case which occurred in the Infirmary here, and was pointed out to me by my late friend *Dr W. Cullen*, the peritonæum alone was extensively softened, and partly dissolved, so as to lay the muscular coat bare on its outer surface. The gelatinization therefore sometimes, though very rarely, begins on the outside of the stomach. Internally the whole is surrounded by pulpiness of the mucous coat, generally white, occasionally bluish or blackish, never granulated like an ulcer, very rarely even vascular; and when it is so, the blood may be squeezed out of the loaded and open vessels. The organs in contact with the hole are also frequently softened. Thus an excavation is sometimes found in the liver or spleen, or the diaphragm is pierced through and through. The margins of the latter holes are quite free from every sign of vascular action, but are generally besmeared with a dark pulpy mass, the remains of the softened tissue. The pulp never smells of gangrene, with which, indeed, this species of softening is wholly unconnected. The edge of the hole in the stomach never adheres to the adjoining organ; yet, even when the hole is very large, the contents of the stomach have not always made their escape. Often the dissolution of the coats is incomplete. *John Hunter* and others, indeed, have said that a stomach is rarely seen without more or less solution of the mucous coat [*]. The best account of the appearances in this state is given by *Jaeger* of Stuttgardt [†].

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* Nouvelle Bibliothèque Médicale, 1828, iii. 141.

The circumstances under which this extraordinary appearance occurs are singularly various. *Professor Chaussier* and the French pathologists conceive it to be always a morbid process constituting a peculiar disease; and doubtless cases have occurred in which death appears to have arisen from the stomach being perforated during life by gelatinization [‡]. But it has been found much more frequently, when death was clearly the consequence of a different disease, and when there did not exist during life a single sign of disorder in the stomach. Thus it has been found in women who died of convulsions after delivery,—in children who died convulsed or of hydrocephalus,—after death from suppuration of the brain, both natural and the result of violence—from diseased mesenteric glands,—from nervous fever,—and after sudden death from fracture of the skull or hanging [§];—and in all of these circumstances it has occurred without any previous symptom referrible to a disorder in the stomach.

The opinions of pathologists, it has been already observed, are divided as to its nature. The French conceive it arises from a morbid corrosive action, which, however, may extend after death, in consequence of the fluids acquiring a solvent power. *Hunter* ascribed it entirely to the solvent power of the gastric juice after death. There are difficulties in the way of both doctrines. A full examination of the whole inquiry, which is one of much interest and considerable complexity, would be misplaced in this work; but some remarks are called for, by reason of the important medico-legal relations of the subject, and the uncertainty in which it is at present involved.

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[*] Philos. Trans. lxii. 450.

[†] See Analysis of his Essay by *Dr Gumprecht*, Lond. Med. Repos. x. 416.

[‡] *Laisné*. Sur les Perforations Spontanées, 149.

[§] The last cases were observed by Hunter. See Philosophical Transactions, lxii. 452.

In the first place, then, it certainly appears very difficult, if not impossible, to comprehend how a vital erosive action can account for the perforations observed after death from diseases wholly unconnected with the stomach, and unattended during life by any symptom of disorder in that organ. For, not to dwell on other less weighty arguments,—on the one hand, there is during life no symptom of perforation, an accident which, if deep stupor be not present at the same time, is always attended with violent symptoms when it arises from any other cause but gelatinization,—and on the other hand, there is frequently no escape of the contents of the stomach into the cavity of the abdomen, though the hole is of enormous size, and its edge not adherent to the adjoining organs. All such perforations, however,—unintelligible as they seem to be on the supposition of a vital erosive action being their cause,—are perfectly well accounted for by what is now known of the properties of the gastric juice, and the changes it undergoes in different circumstances. This will fully appear from the following exposition.

The power of the gastric juice to dissolve the stomach and other soft animal textures was long considered as fully proved by the well-known researches of *Spallanzani* [*], *Stevens* [†], and *Gosse* [‡]. In recent times doubts were entertained on the subject in consequence of negative results having been obtained by other experimentalists, more especially by *Montègre* [§]. But these apparently discrepant facts and opinions have been reconciled very lately by the experiments of *Tiedemann* and *Gmelin* on digestion [‖]; who found that the nature and quality of the fluid secreted by the stomach vary much in different circumstances,—that, when its villous coat is not subjected to some stimulus, the fluid which lines it is not acid, and does not possess any particular solvent action,—but that when the membrane is stimulated by the presence of food or other sources of excitement, the quality of the secretion is materially changed, for it becomes strongly acid and is capable of dissolving alimentary substances both in and out of the body. And still more lately the solvent power of the proper gastric juice over the stomach, and its capability of producing perforation in animals after death, have been established in the most satisfactory manner by *Dr Carswell*[*], who has shown by a series of incontrovertible facts, —that in the rabbit when killed during the digestion of a meal, and left for some hours afterwards in particular positions, all the phenomena of spontaneous gelatinized perforations observed at times in man, may be easily produced at will,—that acidity of the gastric juice is an invariable circumstance when such perforations are remarked,—and that the appearances in question as they occur in the rabbit are the result of chemical action alone, and occur only after death. Thus, then, the physiological experiments of *Tiedemann* and *Gmelin*, together with the investigations of *Carswell*, not merely establish positively the fact, that the stomach may be perforated after death by the gastric juice, but likewise account clearly for the negative results obtained by other experimentalists. For example, passing over earlier experiments, they explain sufficiently the negative results obtained a few years ago by *Dr Pommer* of Heilbronn[†], an experimentalist of some reputation in Germany; for, falling into the error of some of the less recent experimentalists on this subject, he made his observations on animals killed slowly by starving,—in which circumstances there is no proper gastric juice in the stomach, and consequently no solvent action can exist.

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[*] Fisica Animale e Vegetabile. Dissertazione quinta, § ccxxiii.–ccxxxi. T. ii. 86–89, Edit. Venezia, 1782.

[†] De Alimentorum Concoctione. Diss. Inaug. Edinburgi, 1777.

[‡] Experiments on Digestion. Appendix to Spallanzani's Dissertations relative to the Natural History of Animals and Vegetables. London Edition, 1784, i. 317.

[§] Expériences sur la Digestion dans l'homme. Paris, 1814, pp. 20, *et seq.*

[‖] Die Verdauung nach Versuchen, &c. Heidelberg, 1825, or the French Edition, Recherches Expérimentales Physiologiques et Chimiques sur la Digestion, 1826, *passim.*

These statements relative to the causes and phenomena of gelatinized perforation in the stomach supply the strongest possible presumption which analogy can furnish, that a great proportion of spontaneous gelatinized perforations in the human subject are owing to the action of the gastric juice after death. And this presumption is increased to something not far removed from demonstration by the circumstance, that in man the process of softening has actually been traced extending in the dead body. This interesting fact has commonly rested on the authority of *Mr Allan Burns* *; but I am enabled to add that of a very accurate observer and pathologist, *Dr Sharpey* of this city. In the body of a girl who died of diseased mesenteric glands Mr Burns found two days after death an aperture in the fore part of the stomach with the usual pulpy margin; and the liver in contact with the hole was not injured. Without disturbing the parts, he sewed up the body, and left it in a cool place two days longer. The liver opposite the hole had then become pulpy, with its peritonæal coat quite dissolved; and the back part of the stomach opposite the hole was also dissolved, so that only its peritonæal coat remained. The observation made by *Dr Sharpey*, like that of Mr Burns, was accidental. On proceeding to open the body of a child for the purpose of dissecting the nerves, he remarked that the stomach was perforated and gelatinized, but the adjoining organs uninjured. He then sewed up the body in order to show the appearances to some of his friends next day. By that time the peritonæal surfaces of the spleen and left kidney were found much softened and pulpy where they lay in contact with the hole in the stomach.

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[*] Inquiry into the Chemical solution of the stomach after death. Edinburgh Med. and Surg. Journal, xxxiv. 282.

[†] Medizinisch-chirurgische Zeitung, 1828, ii. 57, 77, 93, and 107.

It must be admitted, then, that the action of the gastric juice after death is quite sufficient to account for the greater number of gelatiniform perforations in the human stomach.

But in the second place, it seems scarcely possible to explain every perforation of the kind in this way. The solvent action of the gastric juice, for example, affords no explanation of a singular case related by *M. Récamier* *, where, after death in the secondary stage of small-pox, the stomach was transparent and brittle throughout the greater part of its extent, and perforated in the splenic region by a gelatinized hole large enough to admit the fist,—although the fluid in the stomach was subsequently found to be incapable of dissolving another stomach, and was proved by a careful analysis to be almost entirely destitute of free acid. And still less will the solvent action of the gastric juice account for such cases as those of *Laisné* and *Gastellier*, quoted in p. 119, or the French medico-legal case to be mentioned in p. 133,—where death is preceded by a short illness, indicating a violent disorder of the stomach, and sometimes even characterized by all the marked symptoms of perforation. In the last description of cases, which however are comparatively very rare, it seems necessary to admit that the gelatinization takes place during life; unless, indeed, it be supposed that the stomach is first perforated during life by ordinary ulcerative absorption, and then gelatinized after death, in consequence of the irritation existing before death having given rise to an unusual secretion of gastric juice.

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* Edinburgh Med. and Surg. Journal, vi. 135.

† Journal Complémentaire du Dict. des Scien. Méd. xxxvii. 194.

Passing now to the differences between these gelatinized perforations, and the perforations caused by the corrosive poisons, it may in the first instance be observed, that the margin of a corroded aperture is commonly of a peculiar colour,—for example, yellow with nitric acid, brown with sulphuric acid or the alkalis, orange with iodine. But a much better, perhaps indeed an infallible criterion, and one of universal application, is the following. Either the person dies very soon after the poison is introduced, in which case vital action may not be excited in the stomach; or he lives long enough for the ordinary consequences of violent irritation to ensue. In the former case, as a large quantity of poison must have been taken, and much vomiting cannot have occurred, part of the poison will be found in the stomach: In the latter case, the poison may have been all ejected; but in consequence of the longer duration of life, deep vascularity, or black extravasation must be produced round the hole, and sometimes too in other parts of the stomach, and these will at once distinguish the appearance from a gelatinized aperture. There is no doubt that the stomach may be perforated by the strong corrosives, and yet hardly any of the poison be found in the stomach after death. Thus in a case related by *Mertzdorff* of poisoning with sulphuric acid, where life was prolonged for twelve hours, he could detect by minute analysis only 4½ grains of the acid in the contents and tissue of the stomach. But then the hole was surrounded by signs of vital reaction, and so was the spleen upon which the aperture opened*. Judging from what I have often seen in animals killed with oxalic acid, which is the most rapidly fatal of all the corrosives, so that little time is allowed for vital action, I should think no poison can dissolve the stomach, without unequivocal signs of violent irritation of the undissolved parts of the villous coat, which must secure an attentive observer from the mistake of confounding with such appearances the effects of spontaneous erosion. Spontaneous erosion is very generally united with unusual whiteness of the stomach, and there is never any material vascularity.

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* *Horn's* Archiv für Medizinische Erfahrung, 1823, i. 451.

Resting on the description now given of the spontaneous and poisonous varieties of corrosion, it will be an easy matter, in my opinion, to decide a controversy, which at the time it occurred made a great deal of noise, and upon which the opinions of toxicologists have been unnecessarily divided. It is the question regarding death by poison which occurred in the trial of Mr Angus at Liverpool in 1808 for the murder of his housekeeper Miss Burns. The poison suspected was corrosive sublimate. The symptoms were those of irritation in the alimentary canal,—vomiting, purging, and pain. In the dead body there was not any particular redness either of the intestines or of the stomach; but on the fore part of the stomach an aperture was found between the size of a crown piece and the palm of the hand; it had a ragged, pulpy margin, and the dissolution of the inner coat extended two inches around the margin. No mention is made of adhesion or coloration of the margin. This description, it will be remarked, answers exactly that given above of spontaneous gelatinized perforation; and the absence of the signs of vital action around the hole and in the rest of the stomach is incompatible with the effects of a strong corrosive poison, unless death had occurred very soon after it was swallowed. This, however, was out of the question; for then the poison would have been found in the stomach,—which it was not*.

The case of Angus is not the only instance even in recent times of spontaneous perforation having given rise to an opinion by medical men in favour of poisoning, and consequently to a criminal trial. Six years afterwards a similar incident occurred in France. A young woman near Montargis having died of a short illness, and a large erosion having been found in the stomach after death, six practitioners, on a view of the parts, and without referring to the antecedent symptoms or attempting an analysis of the contents of the stomach, declared that she died of the effects of some corrosive poison. The husband and mother-in-law, against whom there does not appear to have been a shadow of moral evidence, were therefore imprisoned and subsequently tried for their lives. Luckily, however, an intelligent physician of the town saw the error of the reporters, and after vainly endeavouring to persuade them to revise their opinion, was the means of the case being remitted to the Medical Faculty of Paris. That distinguished body, with Professor Chaussier at its head, gave a unanimous and decided opinion, not only that there was not any proof of poisoning, but likewise that the woman could have died of nothing else than spontaneous perforation. The leading features of the medical evidence will at once show how indefensible the conduct and opinion of the original reporters were. The last meal taken by the woman before she became ill, and the only one at which poison could have been administered by the prisoners was her supper; her illness did not begin till past six next morning; the symptoms were mortal coldness, fainting, general pains, headach, pain in the stomach, purging and colic, without vomiting, and she died after twenty-four hours' illness; the morbid appearances were general redness of the stomach, softening and pulpy destruction of a third part of its posterior parietes, and nevertheless the presence in the stomach of a pint and a half of fluid matter, containing evidently the remains of soup taken by the woman after she felt unwell. On the decision of the Parisian Faculty the prisoners were discharged; and the original reporters were deservedly handled with great severity in several publications that appeared not long after*.

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* Trial of Angus for the murder of Margaret Burns, 1808.

Of perforations of the Gullet and Intestines from natural causes, and their distinctions from those produced by poisons. The intestines, and sometimes even the gullet, may be perforated by the same erosive or solvent process as the stomach. Thus Mr Allan Burns observes, that in four plump children, whose previous history he could not learn, he found every part of the alimentary canal, from the termination of the gullet down to the beginning of the rectum, reduced to a gluey, transparent pulp, like thick starch. The bodies were quite free from putrefaction; but the abdomen exhaled a very sour smell when opened. No other organic derangement could be detected [*]. The particulars of a similar case, with an account of the symptoms, have been lately published by *Mr Smith*, a London surgeon: In the body of a child who died of protracted diarrhœa subsequent to weaning, the whole intestines, from the duodenum to the sigmoid flexure of the colon, were found fourteen hours after death gelatinous, semitransparent, and so soft and brittle that they could not bear their own weight, but tore when lifted between the fingers. The stomach and rectum were healthy [†].

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* *Lainé* sur les Perforations de l'Estomac, p. 190, and *Billiard*, Considérations sur l'Empoisonnement par les Irritans, *passim*.

The following case from Laisné's treatise shows that the gullet may be also dissolved exactly in the same way. A woman three days after delivery was attacked with puerperal peritonitis, and died in four days. In the belly were found the usual morbid appearances of peritonitis: but in addition there was in the lower part of the gullet a large oval aperture two inches long, which penetrated through the posterior mediastinum into the lungs [‡]. Another singular instance of the same kind has already been mentioned under the head of the symptoms, (*see p.* 119.) Another has been lately described by *Dr Marshall Hall*. In a child that died of bronchitis, an opening was found in the gullet about the size of a pea, so that the canal of the gullet communicated with the sac of the pleura, and several veins appeared also to have been opened [§]. The stomach was likewise perforated.

It is not difficult to draw the distinction between these perforations and the effects of poison. The throat and gullet may be partially disorganized or corroded by the strong corrosives; but they are very rarely penetrated, since the greater part of the poison must pass into the stomach or be rejected by vomiting. Destruction of the mucous coat is a common consequence, and stricture occasionally follows; but I have hitherto met with only one instance among the innumerable published cases of poisoning with the mineral acids, alkalis, and other corrosives, where the gullet was perforated. In that case the perforation was the result of slow ulceration from poisoning with sulphuric acid, where life was prolonged for two months [||]. Perforation from simple corrosion never occurs. The intestines are never perforated by chemical corrosion from within, for either the poison is in a great measure expelled from the stomach by vomiting, or the pylorus contracts and prevents the passage of every poison that is sufficiently concentrated to corrode. Both the small and great intestines might be corroded from without, in consequence of the poison escaping through a hole in the stomach. I am not acquainted, however, with any case of the kind where intestinal perforation has occurred.

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[*] Edin. Med. and Surg. Journal, vi. 137.

[†] London Medical Gazette, ii. 619.

[‡] Laisné, &c. p. 564.

[§] Edin. Med. and Surg. Journal, xxxii. 38.

[||] London Med. Gazette, xiv. 30.

When the intestines are pierced by true ulceration, it is impossible to tell whether it arose from natural disease or an irritant poison.

The mode of forming a diagnosis between the symptoms and appearances of Irritant poisoning and those of natural disease being thus explained, the different species of poisons which have been arranged in the class of irritants will now be considered in their order.

The Irritant class of poisons may be divided into five orders: The Acids and their Bases; the Alkalies and their Salts; the Metallic compounds; the Vegetable and Animal Irritants; the Mechanical Irritants. In a short Appendix some substances will be mentioned which are not properly speaking poisonous, but are capable of causing violent symptoms when taken in large doses.

The greater number of poisons included in the first order have a very powerful local action. Most of them possess true corrosive properties when they are sufficiently concentrated. Most of them likewise act remotely. One of them, oxalic acid, is evidently not so much an irritant as a narcotico-acrid; but since its most frequent action as seen in man is irritation, it seems inexpedient to break the natural arrangement for the sake of logical accuracy. This is far from being the only instance where the toxicologist is compelled to violate the principles of philosophical classification.

In the present Order are included four of the mineral acids, the sulphuric, nitric, muriatic and phosphoric, with their bases, phosphorus, sulphur, and chlorine: With these may be likewise arranged iodine and bromine, with their compounds, and also oxalic and acetic acid, two of the vegetable acids.

CHAPTER III.

OF POISONING WITH THE MINERAL ACIDS.

Of the mineral acids, the most important, because the most common, are *Sulphuric*, *Hydrochloric*, and *Nitric* acids; and they are sufficiently similar in their effects on the economy to be described under one head. Phosphoric acid is of much less consequence, and will be noticed cursorily.

The Sulphuric acid *(vitriolic acid, vitriol—oil of vitriol)*, Hydrochloric acid *(muriatic acid,—spirit of salt)* and Nitric acid *(aqua-fortis)*, have been long known to be possessed of very energetic properties, and consequently cases of poisoning with them have often been observed. The instances of the kind hitherto published have been chiefly the result of suicide; a considerable number have originated in accident; and, however extraordinary it may appear, a few have been cases of murder. *Tartra* in an excellent memoir on the subject of poisoning with nitric acid, quotes an instance of a woman having been poisoned while in a state of intoxication by that acid being mixed with wine and poured down her throat*. *Valentini* has related the case of a woman who was killed by frequent doses of sulphuric acid given under the pretence of administering medicines†. In 1829 an hospital servant was condemned at Strasbourg for trying to murder his wife in like manner by first making her ill with tartar emetic and then giving her sulphuric acid in syrup, under the pretence of curing her‡. At the Aberdeen Autumn Circuit in 1830 a woman Humphrey was convicted of murdering her husband by pouring the same acid down his throat while he lay asleep with his mouth open§. On the whole, considering the powerful taste and excessively acrid properties of these poisons, it is probable that they will seldom be resorted to for the purpose of making away with another person, who is an adult, and in a state of consciousness. Of late, however, there have been several instances in our country of murder committed on infants in this barbarous manner. A woman Malcolm was executed here in 1808 for murdering her own child, an infant of eighteen months, by pouring sulphuric acid down its throat*; another woman Clark was tried for the same crime at Exeter in 1822; a man was executed lately at Manchester for murdering in the same way his son, a child four years and a-half old†; and the particulars of an interesting trial will be presently noticed, that of Overfield, who was executed at Shrewsbury in 1824, for poisoning his own child in the like manner‡.

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* Traité de l'Empoisonnement par l'acide Nitrique, 1802, p. 87.

† Novellæ Medico-legales, Cas. xxix. p. 211.

‡ Bulletins des Sciences Médicales, Janvier 1830.

§ Edinburgh Medical and Surgical Journal, xxxv. 298.

In a medico-legal point of view, the mineral acids are interesting on another account. Of late a new crime has arisen in Britain, the disfiguring of the countenance by squirting oil of vitriol on it. It originated in one of our great manufacturing towns, Glasgow, during the quarrels in 1820 between masters and workmen regarding the rate of wages §, and became at last so frequent, that the Lord Advocate, in applying for an act of Parliament to extend the English Stabbing and Maiming act to Scotland, added a clause which renders the offence now alluded to capital. In 1828 a woman Macmillan was tried here and condemned under that act ||. The crime has also become lately common in England. I observed three cases noticed in the London papers as having occurred in London in November 1828, and two others near Manchester in the spring of 1829.

The clause of the Scottish act against this crime is as follows: "If any person shall wilfully, maliciously, and unlawfully throw at or otherwise apply to any of his Majesty's subject or subjects any sulphuric acid or other corrosive substance, calculated by external application to burn or injure the human frame, with intent in so doing or by means thereof to murder, or maim, or disfigure, or disable such his Majesty's subject or subjects, or with intent to do some other grievous bodily harm to such his Majesty's subject or subjects; and where in consequence of such acid or other substance being so wilfully, mali-

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* *Burnett* on Criminal Law, 544. *Note.*

† Edinburgh Med. and Surg. Journal, xxxvi. 102.

‡ *Ibidem*, xxii. 222.

§ Report of the Committee of the House of Commons on the Combination Laws, June 1825, pp. 323—328. Evidence of Mr Campbell and Mr Robinson.

|| Cases and Observations in Medical Jurisprudence, Case iii. Edin. Med. and Surg. Journal, xxxi. 229.

ciously, and unlawfully thrown, or applied with intent as aforesaid, any of his Majesty's subjects shall be maimed, disfigured or disabled, or receive other grievous bodily harm,—such person being thereof lawfully convicted, shall be held to be guilty of a capital crime, and shall receive sentence of death accordingly *."

The mineral acids are also very interesting on scientific grounds. They afford by far the purest examples of true corrosive poisons, their poisonous effects depending entirely on the organic injury they occasion in the textures to which they are applied. It is of use to set out, in investigating the effects of poisons, by determining the phenomena presented under such circumstances. When made aware of the rapidity with which other irritating poisons prove fatal, and the slight signs they commonly leave of their operation, one cannot fail to be struck with discovering what the animal frame will sometimes endure from these the most violent of all irritants, and nevertheless recover.

SECTION I.—*Of the Tests for the Mineral Acids.*

In laying down the mode of determining by Chemical Evidence a case of supposed poisoning with any of the three mineral acids mentioned above, it will be unnecessary to notice any of their chemical properties, except those from which their medico-legal tests are derived.

The only common properties that require notice are, their power of reddening the vegetable blue colours, for showing which litmus-paper is commonly used and is most convenient; —and their power of corroding all articles of dress, especially such as are made of wool, hair, and leather. This last property is specified, though a familiar one, because it always forms important evidence in criminal cases. In order to give precision to such evidence, it is necessary to remember, that if the article of dress is a coloured one, it is generally rendered red by the mineral acids; but that the vegetable acids also will redden most articles of dress, although they do not corrode them.

The substance believed to contain the poison may present itself in three different forms, in that of a pure concentrated acid, in a pure diluted state, and in an impure state, being mixed particularly with vegetable and animal matters. The following are the processes by which the presence of each acid is to be proved in any of these states, more particularly the last.

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* Indictment against H. and E. Macmillan, the case related in the work just quoted.

Of the Tests for Sulphuric Acid.

1. *When concentrated* it is oily-looking, colourless, or brownish, without odour, and much heavier than water, and it rapidly corrodes animal substances. If from these properties and its effect on litmus its exact nature is not obvious, it is to be converted into the diluted acid, in doing which the experimentalist will remark that the mixture becomes very hot, if the water is not added too abundantly.

2. *When diluted*, it may be distinguished from the other acids, by adding to it a little nitric acid, and subsequently a solution of the nitrate of baryta. If a heavy white precipitate falls down, it can be nothing else than sulphate of baryta, because no acid but the sulphuric forms with the barytic salts a white precipitate insoluble in nitric acid. The phosphate and carbonate of baryta are both soluble in nitric acid. In applying this test care must be taken to employ nitric acid entirely free of sulphuric,—an admixture which the common nitric acid of the shops almost always contains, and of which it may be freed for the present purpose by solution of nitrate of baryta.

The test now mentioned is alone sufficient to distinguish diluted sulphuric acid from all other acids. As the duty of the medical jurist, however, is to supply not only satisfactory evidence, but also the best evidence which science affords, it is advisable in a criminal case to establish the nature of the precipitate still farther by the following process.

Collect the precipitate on a filter, wash, dry, and remove it. Then mix a little of it (not more than two grains) with a small proportion of dry charcoal powder; and subject the mixture for two or three minutes, in a covered platinum spoon or in a fold of platinum foil, to the flame of a spirit-lamp enlivened with the blowpipe. A portion at least of the sulphate is thus converted into sulphuret of barium. To prove this, put the powder with a little water in the bottom of a small glass tube, add a little hydrochloric acid, and then hold within the tube, without touching the matter below, a bit of white paper moistened with acetate or nitrate of lead. Sulphuretted hydrogen gas is disengaged, which will darken the paper, and likewise often betray itself by its singular odour.

The preceding plan of analysis is applicable only when the experimentalist knows that the subject of examination is one or other of the acids in a simple diluted state,—his only object then being to discover which of them it is. But if unknown neutral salts also exist in the fluid, a different mode of analysis must be followed; for that just related will give all the indications of free sulphuric acid with a fluid, which contains merely a neutral sulphate and a free acid of any kind. The case here supposed is provided against in what will now be said of compound mixtures generally, and is indeed the chief reason which renders a more complicated process necessary for such mixtures.

3. It is seldom that the medical jurist is called on to search for sulphuric acid in either of the simple states already mentioned. Much more generally it has mingled with and acted on various substances, especially of the organic kingdoms, and is likewise accompanied by various acids and neutral salts. The circumstances in which it has usually to be sought for in the practice of medical jurisprudence are twofold,—on the one hand, when it is supposed to be the occasion of stains on clothes,—and on the other, when it is suspected to exist in vomited matter, the contents of the stomach, or organic mixtures generally. Slight differences in the process for detecting it are required in these two cases.

Process for analyzing stains on clothes. When sulphuric acid is thrown upon clothes, it produces a permanent red stain, destroys the cloth entirely or renders it brittle, and in consequence of its strong attraction for water keeps the stain long in a moist state. In the course of the decomposition of the cloth a part of the acid is itself decomposed, sulphurous acid being disengaged. But it is an important medico-legal fact, that after a time the change either goes on very slowly, or is arrested altogether, possibly by the dilution of the acid with moisture from the atmosphere; and that consequently it may be discovered in a free state in stains after a much longer interval than would *à priori* be expected. In the case of Macmillan formerly alluded to, *Dr Turner* and I, who were employed by the crown to examine the different injured articles of dress, found on the man's hat, stock, shirt-collar and coat many discoloured and corroded spots, which were sour to the taste fourteen days after the crime was committed*; in the subsequent case of Mrs Humphrey I discovered six-tenths of a grain of free sulphuric acid in two small spots on a blanket seven weeks after the crime; and from an express experiment on the same blanket with two drops of acid of known strength, it appeared that only one-half of the acid was decomposed in seven weeks †. It may therefore be inferred, that, in every instance where stains have been produced by concentrated sulphuric acid on clothes, at least on woollen clothes, and no attempt has been made to remove the remaining acid by washing or neutralization, a sufficient quantity will be present even after several weeks to admit of being satisfactorily detected by chemical analysis.

The following are the steps of the process which appears to me the most delicate and unequivocal in its indications. First, cut away the stained spots, and expose them for a few minutes in a shallow evaporating basin to the heat of a vapour-bath. Then boil them for a minute or two in several successive small portions of distilled water; and filter if necessary. Next prove the acidity of the fluid by litmus, and likewise by the taste if the quantity of solution is large enough to allow of so coarse a test being used; and with a few drops ascertain the existence of sulphuric acid in one form or another by the nitrate of baryta and nitric acid, as mentioned in the process for the pure diluted acid ‡. If no precipitate is produced, the search for sulphuric acid is at an end. But if a precipitate is produced, it will then be requisite to proceed as follows, in order to determine positively whether the acid is free or combined with a base in the form of a neutral salt.

For this purpose, boil for a few minutes a little pure carbonate of lead in the fluid. Sulphate of lead will be thus formed and thrown down if there is any free sulphuric acid; but none is formed if there is only a neutral sulphate, because carbonate of lead and the neutral sulphates do not decompose one another.

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* Edin. Med. and Surg. Journal, xxxi. 229.

† *Ibidem*, xxxv. 310.

‡ Tentative experiments, like this, are best performed on a small scale, not in a watch-glass, as some recommend, but in such a tube as is represented in Fig. 1, which is made by cutting and closing up with the spirit-lamp one of the little funnels, Fig. 4.

To prove the existence of sulphate of lead in the insoluble matter, first collect it on a filter; wash with distilled water till the powder is freed from the liquid with which it was impregnated; then remove the powder from the filter and treat it with diluted nitric acid quite free from sulphuric. The carbonate of lead is thus dissolved; and if nothing be left, there was of course no free sulphuric acid in the original liquid. If on the contrary a residuum is left by the nitric acid, it is in all probability sulphate of lead, and indicates free sulphuric acid.

But to prove satisfactorily that the salt of lead is the sulphate, remove the solution of nitrate of lead from the insoluble matter by filtration and washing with distilled water; mix the residue carefully while damp with a little distilled water in a mortar; decompose it by a stream of sulphuretted-hydrogen gas, maintained for half an hour or more according to the quantity of the precipitate; then boil immediately to expel the excess of sulphuretted-hydrogen, and filter. There will then be free sulphuric acid in solution, probably with some organic matter, but without any neutral sulphate; and the presence of the acid may be ascertained, as in the case of the pure diluted acid, by precipitation with nitrate of baryta and nitric acid, and the subsequent decomposition of the precipitated sulphate of baryta by means of charcoal and heat.

The object of certain steps in the preceding process, as well as certain fallacies to which it is exposed, will be noticed after the next process has also been described.—The carbonate of lead made use of must be quite free of sulphate of lead, which is almost always contained in the white lead of the shops. On this account care must be taken to ascertain that the carbonate to be employed is entirely soluble in nitric acid; or it may be prepared pure at once by decomposing acetate of lead with bicarbonate of soda, which, as at present found in commerce, is free of sulphates.

Process for the contents of the stomach and other complex mixtures. When sulphuric acid has been mixed with various mineral and organic substances, it may in no long time cease to exist in the free state. Part may be decomposed by the organic matter in the way formerly mentioned. Or the whole may be neutralized at once by earthy or alkaline carbonates, either coming accidentally in contact with it, or administered purposely as antidotes. And it may also be neutralized more slowly by the gradual developement of ammonia in consequence of the decay of the animal matter co-existing in the mixture. Thus in a case mentioned by *Mertzdorff* of a child killed in twelve hours with sulphuric acid, the contents of the stomach did not redden litmus, but on the contrary had an ammoniacal odour; and they contained a considerable quantity of a soluble sulphate, probably the sulphate of ammonia[*]. In like manner *MM. Orfila* and *Lesueur* found that when this acid was left some months in a mixture which contained putrefying azotized matter, it was gradually neutralized by ammonia[†]. Hence the process for detecting sulphuric acid in compound mixtures resolves itself into two,—one for the neutralized, and another for the free acid.

1. The process for a mixture which is neutral or alkaline in its action on litmus is almost the same with that for the pure diluted sulphuric acid. It is merely necessary to filter the suspected mixture before applying the test, and, if carbonate of lime has been given as an antidote, to dissolve the sulphate of lime before filtration by boiling the mixture with a little nitric acid. But of course it is only under very particular conditions that the detection of neutralized sulphuric acid can be taken as proof that it had once existed in the mixture in a free state. These conditions are, 1. previous information, that no neutral sulphate could have been introduced into it; together with proof that a free acid might have been neutralized by one of the causes mentioned above: and 2. in the case of the contents of the stomach, where the natural secretions always contain a small proportion of neutral sulphates,—the discovery of a considerable quantity of the acid. All things considered, then, it is obvious that the discovery of neutralized sulphuric acid is very precarious evidence in cases of suspected poisoning with this substance.

2. The process for a mixture which possesses an acid reaction on litmus is as follows. The first step is to get rid of any free acetic or muriatic acid; which, since the late researches of *Dr Prout*[‡], *Professors Tiedemann and Gmelin*[§], and *MM. Leuret*

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[*] Archiv für Medizinische Erfahrung, 1823, i. 456.

[†] Revue Médicale, 1824, ii. 469.

[‡] Philosophical Transactions, 1824, p. 45.

[§] Die Verdauung nach Versuchen, *passim*.

and Lassaigne[*] on digestion, are well known to exist frequently in the contents of the stomach,—and which will be presently seen to constitute an important source of fallacy in most processes for detecting free sulphuric acid. First, then, filter the suspected mixture, pure water being added if necessary, and distil the filtered liquid in the following manner. Place it in a small mattrass with a short neck, to which a tube with a ball is adapted by a cork (Fig. 2.); and let the part of the tube between the mattrass and ball be a third of an inch in diameter, so that any drop which forms in it may fall back into the mattrass and not be impelled forward beyond the ball. Then, having put the distant end of the tube into the neck of a bottle of the same capacity with the mattrass, and immersed up to the neck in cold water,—distil with a gentle heat till the fluid is reduced to the consistence of a thin syrup. The last portions of the distilled liquid are then to be tested for muriatic acid with nitrate of silver, and for acetic acid by the taste and smell; and if neither acid appear to be present, the matter left in the mattrass may be subjected to the process for detecting free sulphuric acid in stained cloth.—If, on the contrary, either acid be present, distilled water is to be poured into the mattrass, and the mixture again distilled to the consistence of a thin syrup; and this addition of water and distillation must be repeated till the last portions of the distilled liquid give with nitrate of silver no precipitate at all, or a mere haze only, and till the smell and taste of acetic acid entirely disappear. The proper degree to which every distillation should be carried may be conveniently secured, by heating the mattrass in a boiling concentrated solution of muriate of lime. A little sulphuric acid at times rises as high as the ball; the remedy for which is to wash the ball with a few drops of distilled water and add the washings to the mattrass, before each repetition of the distillation.

After the preceding step, the residual fluid in the mattrass will contain either no acetic and muriatic acid, or a mere trace only, while scarcely any free sulphuric acid passes over into the bottle, if the distillation be properly managed. I have found that a drachm of muriatic acid, and as much acetic acid, were driven off entirely by six distillations from a solution of sulphate of soda containing two drops of sulphuric acid, without any material quantity of the sulphuric acid escaping; and in another trial with a mixture of bread, milk, muriatic acid, acetic acid, and four drops of sulphuric acid, the two former acids were driven off by four distillations, while almost the whole sulphuric acid remained behind.

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[*] Recherches Physiol. et Chim. pour servir à l'histoire de la digestion, *passim*

When thus prepared, therefore, the matter in the mattrass may be subjected to the process for detecting free sulphuric acid in stains on clothes. The first measure in that process, the exposure of the suspected matter to heat in an evaporating basin, is of course, however, unnecessary.

A few remarks may now be made on the fallacies to which the preceding processes for detecting sulphuric acid are exposed. The detection of small quantities of this acid in a free state, it may be inferred, is far from being so easy as might be imagined from its very characteristic properties. The chief source of ambiguity and difficulty is the possible co-existence of neutral sulphates with any free acid, especially muriatic or acetic acid, —a conjunction of substances which is far from being unfrequent in such mixtures as may come under the cognizance of the medical jurist.

The process recommended for compound mixtures in the first edition of this work is fallacious: In a mixture, containing a neutral sulphate and free muriatic and acetic acid, free sulphuric acid will be indicated by it. The same objection applies to another process suggested by *Orfila* and adopted by *Devergie* *. In order to overcome this difficulty, it is advisable to get rid of the free muriatic and acetic acids; for which purpose the plans mentioned above have occurred to me as the most effectual. In the instance of stains on cloth, any free muriatic or acetic acid, which might remain after some days' exposure to the air, will be removed by simply exposing the stained cloth to a moderate heat. In the instance of compound mixtures, the more tedious process of repeated distillation will accomplish the same end.

Still the processes now recommended are not entirely free from objection. In the first place, they will not always indicate free sulphuric acid, although it is present; for if any muriate, acetate, or nitrate is also present in such quantity that the base of the salt can neutralize the whole sulphuric acid,—the salt is decomposed in the course of distillation, and its acid driven off, so that a neutral sulphate remains. Perhaps, too, in other cases the sulphuric acid is decomposed during distillation by the action of various organic matters present; but so far as I have examined the subject, it appears that when free sulphuric acid exists in small proportion in an organic mixture very little of it is thus dissipated. In the second place, both the processes may indicate sulphuric acid where it does not exist. The fallacy arising from a mixture containing a neutral sulphate and free muriatic or acetic acid, is provided against. But the corresponding fallacy occasioned by the co-existence of a neutral sulphate and free nitric acid will still remain; for this acid is not easily removed by exposure to a heat a little above 212°; and it will cause the formation of sulphate of lead by mutual action between the carbonate of lead and the sulphate in the mixture, although no sulphuric acid exist in a free state,—because a nitrate of lead is first formed, and an interchange then takes place between the nitrate of lead and any neutral sulphate which may happen to be in solution. I am not aware that this source of fallacy can be obviated in any other way except by an analysis directed to discover nitric acid.

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* Annales d'Hygiène Publique et de Médecine-Légale, ii. 213. For a detail of the objections to this method the reader may consult Edinburgh Medical and Surgical Journal, xxxv. 312.

To conclude, it is important to remember, that, although free sulphuric acid be positively detected in a compound mixture, it does not absolutely follow that sulphuric acid was mixed with it. The free acid may arise from an accidental impregnation with one of the supersulphates, more especially alum. This difficulty is of little or no consequence in regard to stains on clothes, because alum cannot cause any corrosion. But as to the contents of the stomach, another common subject of analysis in medico-legal investigations, the only mode of avoiding the fallacy is to ascertain by general evidence that alum or any other supersulphate could not have been administered recently before death.

A different process for detecting sulphuric acid in compound mixtures has been recently proposed by *MM. Orfila* and *Barruel*, and somewhat modified by *MM. Devergie* and *Taufflieb.* The mixture is distilled to dryness in a proper retort and receiver, and then exposed to a heat gradually raised to low redness; and the substances which pass over are condensed in water rendered feebly alkaline by ammonia. Any free sulphuric acid in the mixture passes over in the form either of sulphuric or of sulphurous acid. The distilled fluid being then put into an apparatus such as that represented in Fig. 5, nitromuriatic acid is poured into the straight tube in successive portions so long as there is effervescence; and the gaseous fluids evolved are received by the curved tube in a solution of iodic acid. The greater part of any sulphurous acid which may have been contained in the distilled liquid is converted by the nitromuriatic acid into sulphuric acid; and what escapes this change passes over into the iodic acid, and is there converted into sulphuric acid with the disengagement of iodine, which colours the solution brown. Sulphuric acid may now be sought for in the usual way in the liquid which has been acted on by the nitromuriatic acid. And in the solution of iodic acid it may be discovered by precipitating the iodic and sulphuric acids with nitrate of baryta; heating the dry precipitate to a full red or low white heat, by which the iodate of baryta is decomposed; acting on the residuum with nitric acid which leaves undissolved the sulphate only; and decomposing the sulphate with charcoal as already described *.

Is it not a sufficient objection to this process that a neutral sulphate of ammonia might pass over into the receiver at the temperature employed, and that fixed sulphates might be decomposed in the course of the complicated actions that occur in the destructive distillation of organic matters, and sulphurous acid be some times thus disengaged and obtained in the receiver, although the subject of analysis did not contain any free sulphuric acid?

Of the Tests for Nitric Acid.

1. *When concentrated*, Nitric acid is easily known by the odour of its vapour, which is peculiar. When pure, the acid as well as its vapour is colourless; when mixed with nitrous acid it is of various tints, and generally yellow or orange. The acid of commerce is at times rendered impure by sulphuric acid, a circumstance which must be attended to in applying the sub-

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* Annales d'Hyg. Publique et de Méd. Lég. xiii. 438.

sequent tests.—The simplest test for the nitric or nitrous acid is the action of copper, lead, or tin. If any of these metals in small fragments, or tin powder be thrown into either acid previously diluted with an equal volume of water, an effervescence takes place, which in the case of lead or copper is much accelerated by heat; nitric oxide gas is disengaged; and ruddy fumes of nitrous acid gas are formed when the gas comes in contact with the oxygen of the air. Another characteristic test, which has the advantage of being applicable on an extremely small scale, is morphia, the alkaloid of opium. This substance is turned in a few seconds to a beautiful orange-red colour by nitric acid, and after longer contact forms with it a bright yellow solution. No other acid has this effect. Muriatic acid, as *Dr O'Shaughnessey* has remarked [*], does not act at all on morphia, and sulphuric acid chars and blackens it.—Many other characteristic tests might be mentioned for nitric acid; but those now specified are amply sufficient.

2. *In a diluted state* this acid is not so easily recognized as the other mineral acids, for it does not form any insoluble salt or precipitate with bases.

The process usually followed consists in first ascertaining the acidity of the fluid, neutralizing with potass, evaporating to dryness, and ascertaining by the addition of sulphuric acid and the application of heat, whether nitrous fumes are evolved. When the quantity of acid in the suspected fluid is sufficiently large, for example, about three grains, this process may be employed with advantage: By using a very small distilling apparatus, and operating cautiously, the leading properties of the disengaged acid may be determined; and, at all events, a sufficient quantity may be procured to try on it the test of morphia.—But when there is a probability that the quantity of acid is very small, a different plan must be followed. After neutralization and evaporation to dryness, the residue is to be put in a small tube, and heated for a second or two with a drop of sulphuric acid. A crystal of morphia is then to be dropped into the mass and moved round the edge of it, or in the moisture on the tube immediately above; upon which, if any nitric acid was originally present, the morphia will quickly acquire an orange colour. This mode of procedure, which may be applied to a very minute quantity of acid, was pointed out lately by *Dr O'Shaughnessey* [*].

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[*] Lancet, 1829–30, ii. 330 and 432.

3. *When in a state of compound mixture*, nitric acid, like sulphuric acid in similar circumstances, may be after a time partly decomposed and partly neutralized; and when the matter with which it is mixed belongs to either of the organic kingdoms, more particularly if it is of an animal nature, its decomposition is more rapid than that of sulphuric acid. Still it is an important fact, that some of the acid may be discovered after a considerable interval. *M. Ollivier* detected it in various stains on the skin at least a day after it had been applied [†]; *Dr O'Shaughnessey* detected it in a stain on cloth sent to him from Ireland to Edinburgh [‡]; and I have found it in stains made on broadcloth with detached drops seven weeks before.—When nitric acid is to be sought for in stains on cloth or on the skin, it may be detected with great nicety by a simple process; but when mixed with the contents of the stomach or other organic fluids, its detection is by no means either so easy or so certain.

Process for stains. Nitric acid produces on the skin a yellow stain, which gradually becomes dirty orange, and then, as the cuticle desquamates, of a dirty yellowish-brown; but in all of these states it is at once rendered for a time lively yellow in tint by the action of ammonia. I am not aware that any other yellow stain is similarly affected. Stains on cloth are generally yellowish, reddish-yellow, and brownish-yellow, and are attended with more or less disintegration of the texture of the cloth. The method of analyzing all these stains is as follows.—The stained part is to be boiled in a few drachms of pure water several times in succession; and the liquid is then filtered and may be subjected to litmus paper for the purpose of ascertaining its acidity. The absence of muriatic and sulphuric acids may next be proved on a drop or two contained in the small glass tube, Fig. 1, by the non-action of nitrate of silver on the one hand, and nitrate of baryta on the other. It should be remembered at the same time, that, although the free acid be really the nitric, a scanty precipitate may be produced by one or both of these tests for the two other common mineral acids; because old clothes are frequently impregnated with particles of their salts, more especially with sulphates.—The mixture is then to be rendered neutral, or for the sake of greater facility, feebly alkaline, by adding a few drops of a diluted solution of caustic potass; after which the whole is evaporated to dryness, and in a vapour-bath, if practicable. The dry residuum is now to be put into a small short tube, heated with a drop or two of sulphuric acid, and brought in contact with a fragment of morphia, as recommended above in the process for the pure diluted acid. But if there is any reason to think that the quantity of acid is moderately large, it should be collected pure by a regular process of distillation.

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[*] Lancet, 1829–30, ii. 840.

[†] Archives Générales de Médecine, xxi. 365.

[‡] Lancet, 1829-30, ii. 840.

This method is almost identical with one proposed by *Dr O'Shaughnessey* in one of his papers formerly mentioned [*]. He applied it successfully to a stain sent to him at Edinburgh from Ireland. It is described above as I applied it, a few days before seeing his account, to a stain on broad-cloth made with a single drop of pure nitric acid, and forty-nine days old. If the stain be large, and the quantity of dry matter procured from it exceed a few grains, Dr O'Shaughnessey properly recommends the experimentalist to put it with sulphuric acid in a little tube with a ball, to distil off the nitric acid into another tube containing a few drops of water, and to apply to this acid the various tests mentioned formerly; but at the same time I am inclined to think with him that the single test of morphia, when applied to a substance procured in the manner specified, supplies sufficient evidence.—The kind of morphia which I find to answer best is considerably purer than what is generally met with in the shops at present,—being in distinctly-transparent crystals, nearly, yet not entirely, colourless. The common impure morphia of the shops gives a less lively orange tint; and morphia perfectly pure is said not to be affected at all [†]. The morphia, therefore, before being used in a medico-legal case, should be tested by a comparative trial on a fragment of nitre decomposed in a tube by sulphuric acid.

Process for Mixtures. The detection of nitric acid in compound mixtures, such as the contents of the stomach, is seldom so easy a matter as its detection in stains; and indeed a sure and delicate process is still a desideratum in medico-legal chemistry.

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[*] Lancet, 1829-30, ii. 840.

[†] I have never obtained morphia, however colourless, which was not affected strongly by nitric acid.

When the proportion of the acid in the mixture is considerable, it may be detected without difficulty. It is merely necessary to neutralize with potass, water being added if necessary, and then to filter and evaporate to a convenient degree of concentration. Crystals will then be formed on cooling, and these may be decomposed by sulphuric acid in the usual way. But the medical jurist ought not to flatter himself with the expectation of meeting often with a proportion large enough to admit of being discovered by so coarse a method of analysis. In general the quantity is so small, that the crystallization of the nitrate of potass is prevented by the animal or vegetable matter with which it is mingled.—When the proportion appears inconsiderable, therefore, a different process must be pursued; and on the whole the following has appeared to me the most effectual and delicate.

The first step is to try how far the organic matter may be sufficiently removed by a carefully conducted filtration as to admit of the nitre crystallizing. For this end, having constructed a loosely twisted cord of filtering-paper, about eight inches long, and bent like a syphon,—place the shorter limb in the suspected mixture, which must be previously neutralized and diluted to the requisite extent, and place a proper vessel to receive the drops which fall from the other end of the syphon-filter. Then cover the whole apparatus with a jar to prevent evaporation. In the course of twenty-four or forty-eight hours the fluid will thus undergo a process of compound filtration, and will sometimes be so free from organic substances as to yield by evaporation crystals of nitre sufficiently pure to present the characteristic action on morphia when decomposed by sulphuric acid.

In some instances, however, the result is different. On the one hand, if a moderate proportion of organic matter be mixed with the crystals, and the quantity of residuum is not sufficient to allow of the nitric acid being separated by distillation, the colour of the mass after the action of the sulphuric acid is so deep as completely to obscure the effect of the disengaged nitric acid on morphia. And on the other hand, if chloride of sodium is mixed with the crystals of nitre, as will occasionally happen in medico-legal inquiries, the sulphuric acid will disengage, not nitric acid, but chlorine.

I have tried various plans for obviating these sources of difficulty, but have not been so successful as I could wish. Both difficulties, however, are in a great measure removed by means of the acetate of silver. The residue of the evaporation being redissolved and filtered, the acetate of silver is to be added in slight excess. The hydrochloric acid is thus thrown down in the form of chloride of silver; and along with it several organic principles are likewise precipitated. The solution being afterwards filtered and evaporated to dryness, the residue may be treated with sulphuric acid and morphia in the usual manner.

The preceding process requires a few commentaries.

When in a compound mixture, containing nitric acid neutralized by potass, crystallization cannot be accomplished on account of the animal or vegetable matter co-existing in the fluid, —the method recommended by some is simply to evaporate to dryness and to raise the heat gradually, with the view of producing deflagration. But this is a coarse, uncertain, and fallacious process. It is uncertain, because when the proportion of nitre is small, no deflagration ensues, but merely effervescence. And it is fallacious; for, as *Dr O'Shaughnessey* properly cautions the medico-legal chemist, other salts besides nitre, such as the chlorates and oxalates, possess the power of deflagrating with organic matter.

The first step in the process recommended above consists in a peculiar mode of filtration proposed by *Dr O'Shaughnessey* *, who has examined the whole medico-legal chemistry of nitric acid with much ability. This step will be sometimes sufficient of itself to procure the crystallization of the nitre. Dr O'Shaughnessey found, that from a mixture of three ounces of thick pea-soup and ten drops of nitric acid neutralized by potass, he procured in twenty-four hours a limpid fluid which yielded by evaporation long crystals of nearly pure nitrate of potass. I fear, however, that this plan of filtration will not always enable the nitre to crystallize in a sufficiently pure state. I have found the contents of the stomach so viscid as to require considerable dilution to allow of the fluid part passing along the filter; in which case so much organic matter is dissolved by the fluid, as to prevent the crystallization of the nitre: And from a mixture of common barley-broth with nitre in the proportion of six grains to four ounces, there was procured by filtration and evaporation a crystalline residue, which, owing to the chloride of sodium mixed with the nitre, gave with sulphuric acid no nitric acid, but a copious evolution of chlorine gas. To obviate these inconveniences, I have proposed to remove the chlorine of the chloride of sodium, as well as some of the organic matter by means of acetate of silver. This plan has appeared convenient in such trials as I have hitherto made of it. In one experiment four drops of nitric acid neutralized with potass were mixed with six ounces of strong barley-broth. In three days half an ounce of limpid fluid was procured by filtration. One-half of this evaporated to dryness in a vapour-bath gave a crystalline, deliquescent residue, which, heated with sulphuric acid in a tube, emitted a strong odour of chlorine; and the moisture which bedewed the tube scarcely imparted any colour to a fragment of morphia. The dry residuum of the other half of the filtered fluid was re-dissolved and precipitated by an excess of acetate of silver, then again filtered and evaporated to dryness, and the residue was gently heated in a tube with sulphuric acid. An odour of nitric acid was now disengaged, and the moisture on the tube close to the mixture turned a fragment of morphia to bright orange-red.

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* Lancet, 1830-31, i. 610.

The acetate of silver is prepared by mixing together strong solutions of acetate of potass and nitrate of silver, draining and compressing between folds of bibulous paper the crystalline precipitate which forms, and then dissolving this precipitate in boiling water and crystallizing by refrigeration. The crystals, which are sparingly soluble in cold water, should be then separated, slightly washed with a little water, and again dried by compression. When put to use, a boiling solution should be employed, as the solution at low temperatures contains very little of the salt. In preparing solutions of this salt, it is proper to boil as little as possible, and rather, indeed, to heat the water within a few degrees of ebullition, and then effect the solution of the salt by brisk agitation; for at the temperature of ebullition the acetate of silver is quickly decomposed. The salt should be kept in the solid state, as its solution slowly undergoes decomposition.

Dr O'Shaughnessey, in a paper antecedent to that last quoted, has given another process for separating nitric acid in the form of nitrate of potass*. I have not thought it necessary, however, to give any account of this plan, because on attempting to apply it to the contents of the stomach, I could not succeed in removing the animal matter sufficiently to permit the remainder of the analysis to be brought to a successful issue.

Of the Tests for Hydrochloric Acid.

1. Hydrochloric acid is *in its concentrated state* of a yellowish colour as usually sold, and is easily known by its peculiar vapour or fumes. A convenient additional test, which, however, is not absolutely distinctive, is the formation of white vapour when a rod dipped in it is brought near another rod dipped in ammonia. If any farther evidence be desired, the strong acid must be diluted with water, and examined by the tests for it in a diluted state.

2. *When diluted*, it is recognized with facility first by litmus-paper, and then by the nitrate of silver, which forms with it a dense, white precipitate, the chloride of silver. A similar precipitate, indeed, is produced by the same test in other diluted acids. But the chloride of silver may be distinguished from all other white salts of silver by one or other of the following characters. If the quantity precipitated be considerable, it should be collected on a filter, dried and heated in a tube; upon which it fuses under the point of redness, and, unlike the other white salts of silver, remains at a red heat undecomposed, and on cooling forms a crystalline, sometimes translucent mass, which cuts like horn. If, on the other hand, the quantity of precipitate be too small to be collected, it is first to be re-dissolved in a few drops of ammonia, and then made to re-appear by a few drops of nitric acid, after which it will be remarked that an excess of that acid does not redissolve it. The other white insoluble salts of silver, which are dissolved by ammonia, are also soluble, except one, in an excess of nitric acid, so that, on this acid being gradually added to their ammoniacal solution, they first reappear and then are again dissolved. The exception is the cya-

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* Lancet, 1829–30, ii. 333.

nide of silver, as thrown down for example by nitrate of silver in weak hydrocyanic acid; and this salt is easily known by the effect of heat, which darkens it, and disengages cyanogen.—[See Tests for Hydrocyanic acid.]

3. Hydrochloric acid *in a state of compound mixture* has not been much attended to as an object of medico-legal analysis. In truth, this acid very rarely comes under the cognizance of the medical jurist at all. It is not a little singular that there should be on record, so far as I know, but one case of poisoning with a substance so energetic and in such common use *.

The presence of organic substances in the mixture will entirely prevent the application of the process for the pure diluted acid; because, besides that such mixtures almost always contain hydrochlorates, there are few organic principles, more especially of the animal kingdom, which do not precipitate abundantly with nitrate of silver. It is easy, however, to get rid of this fallacy by a cautiously managed distillation.

The process, then, for hydrochloric acid in a state of compound mixture, is to subject the mixture to distillation in the apparatus represented in Fig. 2; and the heat is to be regulated by immersing the body and part of the neck of the mattrass in a boiling solution of hydrochlorate of lime, in the proportion of two parts of the crystallized salt to one of water, or equal parts of the anhydrous salt or chloride of calcium and water. In this bath, in which a temperature about 240° may be maintained, the mixture is first to be distilled to dryness; and then the operation is to be repeated after adding a little distilled water to the dry residuum. The distilled fluids may then be treated as a pure diluted acid.

The peculiar advantages of this mode of procedure are, that, of the substances which will probably be met with in a medico-legal analysis, acetic and hydrochloric acids will alone be distilled over,—that no free sulphuric acid can pass over,—and likewise in particular no hydrochlorate of ammonia, except a mere trace, which is barely sufficient to communicate a slight haze to the distilled liquid on the addition of the nitrate of silver.—The distillation of a little pure water from the dry residuum of the first operation is recommended, because without it a considerable quantity of hydrochloric acid will always be found to remain behind in the form of gas or vapour in the mattrass.

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* Toxicologie Générale, i. 183.

In the case of an analysis of the contents of the stomach or vomited matter, it must not be forgot, that the discovery of free hydrochloric acid is no proof that this acid obtained entrance into the stomach from without; because, as formerly noticed, the researches of *Dr Prout*[*] and of *Professors Gmelin* and *Tiedemann*[†], as well as those of *Mr Children*[‡] and others have proved, that during digestion hydrochloric acid is secreted as an essential ingredient of the gastric juice, and that in some diseased states of digestion it exists in the secretions of the stomach in increased quantity. How far this important source of fallacy will weaken the evidence of poisoning with hydrochloric acid derived from the detection of the acid within the stomach or in vomited matter, it is not at present very easy to pronounce. On the whole, the medico-legal chemist must be cautious in inferring the introduction of hydrochloric acid from without unless where the quantity is considerable. I am not prepared to say what quantity would justify such an inference; but the proportion usually contained in the gastric juice appears to be small; and the proportion found by *Dr Prout* in the fluid of pyrosis was only between 4.28 and 5.13 grains of pure acid in sixteen ounces[§].—Another source of fallacy is, that a mixture containing a hydrochlorate and free sulphuric acid will yield hydrochloric acid by distillation. If this fallacy be apprehended, it may easily be got rid of in some instances by examining the residual matter in the mattrass, and ascertaining that no material quantity of sulphuric acid exists in it. If, however, a considerable quantity of that acid be found, it is extremely difficult to ascertain which of the two acids originally existed in the free state.—The quantity of hydrochloric acid in a suspected mixture may be estimated by collecting the chloride of silver thrown down by the nitrate of silver, fusing and weighing it, and allowing 100 parts of the concentrated hydrochloric acid of the shops for every 145 parts of the fused chloride.

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[*] Philosophical Transactions, 1824, p. 45.

[†] Die Verdauung nach Versuchen, *passim*.

[‡] Annals of Philosophy, 1824, viii. 68.

[§] Philosophical Transactions, p. 49.

SECTION II.—*Of the Mode of Action of the Mineral Acids, and the Symptoms they cause in Man.*

It was formerly observed that the action of the strong mineral acids is independent of the function of absorption. They act by the conveyance along the nerves of an impression produced by the irritation or destruction of the part to which they are applied.

When introduced directly into a vein they cause death by coagulating the blood. Thus, when *Professor Orfila* injected into the jugular vein of a dog half a drachm of sulphuric acid, diluted with an equal weight of water, he observed that the animal at once struggled violently, stretched out its limbs, and expired; and on opening the chest immediately, he found the heart and great vessels filled with coagulated blood *.—Nitric acid and hydrochloric acid act in the same way.

If, on the other hand, they are introduced into the stomach, the blood as usual remains fluid for some time after death; the symptoms are referrible almost solely to the abdomen; and in the dead body the stomach is found extensively disorganized, and the other abdominal viscera sometimes inflamed. If the dose be large, and the animal fasting, death may take place in so short a time as three hours; but in general it lives much longer.†

When the strong mineral acids are applied outwardly they irritate, inflame, or corrode the skin. The most rapid in producing these effects is the nitric, or rather the nitrous acid. The strong, fuming nitrous acid even causes effervescence when dropped on the skin.

The toxicologist is indebted for his knowledge of the symptoms caused by these acids in man chiefly to the work of *M. Tartra* on poisoning with Nitric Acid, to which the reader may refer for greater details, and many excellent cases ‡. Tartra has so completely exhausted the subject, that it will be seldom requisite in the following abstract to quote any other author.

M. Tartra considers that four varieties may be observed in the effects of the nitric and other mineral acids. 1. Speedy death from violent corrosion and inflammation; 2. Slow death from a peculiar organic disease of the stomach and intestines; 3. Imperfect recovery, the person remaining liable ever after to irritability of the stomach; 4. Perfect recovery.

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* Toxicologie Générale, i. 77.

† Ibidem, 78.

‡ Traité de l'Empoisonnement par l'acide Nitrique, 1802.

1. The most ordinary symptoms are those of the first variety,—namely, all the symptoms that characterize the most violent gastritis, accompanied likewise with burning in the throat, which is increased by pressure, swallowing, or coughing [*];—eructations proceeding from the gases evolved in the stomach by its chemical decomposition;—and an excruciating pain in the stomach, such as no natural inflammation can excite. The lips are commonly shrivelled, at first whitish, afterwards, if from nitric acid, yellowish, if from sulphuric acid, brownish. Occasionally there are also excoriations, more rarely little blisters. Similar marks appear on other parts of the skin with which the acid may have come in contact, such as the cheeks, neck, breast, or fingers; and these marks undergo the same change of colour as the marks of the lips. I had an opportunity of witnessing this in the case of the man who was disfigured by the Macmillans with sulphuric acid. He was cruelly burnt on the face as well as on the hands, which he had raised to protect his face; and the marks were at first white, but in sixteen hours became brownish. The inside of the mouth is also generally shrivelled, white, and often more or less corroded; and as the poisoning advances, the teeth become loose and yellowish-brown about the coronæ. The teeth sometimes become brown in so short a time as three hours [†]. Occasionally the tongue and inside of the cheeks are white, and as it were polished, like ivory [‡]. The colour of the tongue in the case of nitric acid is sometimes yellow, as in a case recently related by *Mr Arnott* of London [§]; but this is by no means invariable. [||] There is almost always great difficulty, and sometimes complete impossibility of swallowing. In the case of a child related by *Dr Sinclair* of Manchester, fluids taken by the mouth were returned by the nose; and the reason was obvious after death;

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[*] *Lebidois*, Arch. Gén. de Méd. xiii. 367.

[†] *Martini* in Rust's Magazin für die gesammte Heilkunde, xviii. 159.

[‡] *Correa de Serra* in Journal de Chimie Médicale, ii. 209, on the third day.

[§] London Medical Gazette, xii. 219.

[||] Ibidem, viii. 767.

for even then the pharynx was so much contracted as to admit a probe with difficulty*. In Mr Arnott's patient substances taken by the mouth were discharged by an opening in the larynx which had been made to relieve impending suffocation. The matter vomited is generally brownish or black, and causes effervescence on the pavement, if it contains any lime. Afterwards this matter is mixed with shreds of membrane, which resemble the coats of the stomach, and sometimes actually consist of the disorganized coats, but are generally nothing more than coagulated mucus. The bowels are obstinately costive, the urine scanty or suppressed; and the patient is frequently harassed by distressing tenesmus and desire to pass water. The pulse all along is very weak, and towards the close imperceptible, sometimes intermitting. It is not always frequent; on the contrary, it has been observed of natural frequency, small and feeble in a patient who survived fifteen days†. The countenance becomes at an early period glazed, and the extremities cold and clammy. The breathing is often laborious, the movements of the chest increasing the pain in the stomach, independently of the pulmonary inflammation which is also at times present. To these symptoms are added occasional fits of suffocation from the shreds of thick mucus sticking in the throat, and sometimes croupy respiration, with sense of impending choking where the larynx has suffered injury.

Such is the ordinary train of symptoms in cases of the first variety. But sometimes, especially when a large dose has been swallowed, instead of these excruciating tortures, there is a deceitful tranquillity and absence of all uneasiness. Thus, in the case of a woman who was poisoned by her companions making her swallow while intoxicated aqua-fortis mixed with wine, although she had at first a good deal of pain and vomiting, there were subsequently none of the usual violent symptoms; and she died within twenty hours, complaining chiefly of tenesmus and excessive debility‡. Occasionally eruptions break out over the body§; but their nature has not been described.

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* Edinburgh Med. and Surg. Journal, xxxvi. 103.

† Archives Générales de Médecine, xiii. 367.

‡ *Tartra*, p. 87.

§ *Desgranges*, Recueil Périodique de la Société de Médecine, vi. 22. *Tulpius*, Observationes Medicinales, iii. 43.

The duration of this variety of poisoning with the acids is commonly between half a day and two or three days. But sometimes life is prolonged for seven * or fifteen days †; and sometimes too death takes place in a few hours. The shortest duration among the numerous cases of adults mentioned by Tartra is six hours ‡; but *Dr Sinclair* of Manchester has related a case which lasted only four hours and a-half §; and *Professor Remer* of Breslau once met with a case fatal in two hours ||.

The quantity required to produce these effects has not been ascertained, and must be liable to the same uncertainty here as in other kinds of poisoning. The smallest fatal dose of sulphuric acid I have hitherto found recorded was one drachm. It was taken with sugar by mistake for stomachic drops by a stout young man, and killed him in seven days ¶. A man has recovered after taking six drachms **. In the only case of poisoning with hydrochloric acid which I have met with in authors, an ounce and a-half proved fatal in little more than a day ††.

2. The second variety of symptoms belong to a peculiar modification of disease, which is described by Tartra in rather strong language. It begins with the symptoms already noticed; but these soon abate in violence. The patient then becomes affected with general fever, dry skin, spasms and pains of the limbs, difficult breathing, tension of the belly, salivation, and occasional vomiting, particularly of food and drink. Afterwards membranous flakes are discharged by vomiting, and the salivation is accompanied with fœtor. These flakes are often very like the mucous membrane of the stomach and intestines; and such they have often been described to be. More probably, however, they are of adventitious formation; for the mere mucous coat of the alimentary canal cannot supply the vast quantity that is discharged. Sometimes worms are discharged dead, and evidently corroded by the poison ‡‡. Digestion is at the same time deranged, the whole functions of the body are languid, and the

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* Journal der Praktischen Heilkunde, vii. ii. 18.

† Archives Générales, xiii. 367.

‡ *Tartra*, p. 160.

§ Edinburgh Med. and Surg. Journal, xxxvi. 102.

|| Journal der Praktischen Heilkunde, xlix. iii. 60.

¶ *Ibidem*, vii. ii. 18.

** Martini's case.

†† *Serres* in Orfila, Toxicologie Générale, i. 133.

‡‡ *Tendering* in Horn's Archiv für Medizinische Erfahrung, 1825, i. 458.

patient falls into a state of marasmus, which reduces him to a mere skeleton, and in the end brings him to the grave. Death may take place in a fortnight, or not for months. In one of Tartra's cases the patient lived eight months. The vomiting of membranous flakes continues to the last.

3. The third variety includes cases of imperfect recovery. These are characterized by nothing but the greater mildness of the primary symptoms, and by the patient continuing for life liable to attacks of pain in the stomach, vomiting of food and general disorder of the digestive function.

4. The last variety comprehends cases of perfect recovery. which are sufficiently numerous even under unpromising appearances. From the average of 55 cases recorded by Tartra it appears that the chances of death and recovery are nearly equal. Twenty-six died, 19 of the primary, 7 of the secondary disorder. Twenty-nine recovered, and of these twenty-one perfectly. Suicidal are for obvious reasons more frequently fatal than accidental cases.

Tartra has not taken notice in his treatise of another form of poisoning with the strong acids,—in which the injury is confined to the gullet and neighbouring parts. In Corvisart's Journal there is the case of a man, who began to drink sulphuric acid for water while intoxicated, but suddenly found out his error before he had swallowed above a few drops; and consequently the chief symptoms were confined to the throat. After his physician saw him he was able to take one dose of a chalk mixture; but from that time he was unable to swallow at all for a fortnight [*]. *Martini* likewise met with a similar instance of complete dysphagia from stricture in the gullet caused by sulphuric acid [†]. His patient recovered.

It also appears exceedingly probable, although no systematic writer has to my knowledge laid it down,—that the strong acids may cause death, without reaching the stomach or even the gullet, by exciting inflammation and spasm of the glottis and larynx. Such an effect may very well be anticipated from an attempt to commit murder with these poisons; as the person, if he retains consciousness at the time, may become aware of their nature before he has swallowed enough to injure the stomach. On these grounds, an opinion in favour of poisoning was given by one of the Prussian medical colleges in the case of a new-born child, in which the stomach and intestines were healthy, and did not contain poison, but in which the cuticle of the lips was easily scraped off, the gums, tongue, and mouth yellowish-green, as if burnt, the velum and uvula in the same state, the rima glottidis contracted, and the epiglottis, larynx, and fauces violently inflamed. Sulphuric acid was found in the house; and the mother subsequently confessed the crime[*].—A case was formerly quoted (p. 77,) where *MM. Ollivier* and *Chevallier* found traces of the action of nitric acid on the lips, mouth, throat and upper fourth of the gullet, but not lower. In this instance the reporters came to the opinion from the absence of injury in the more important parts of the alimentary canal, as well as from the marks of nail-scratches on the neck, and the gorged state of the lungs, that death had been produced by strangling after an unsuccessful attempt by the forcible administration of nitric acid. It is quite possible, however, that death might quickly ensue from the effects of the poison on the throat and gullet; M. Ollivier in relating the case says that in the course of the judicial inquiries *M. Alibert* stated that he had known repeated instances of death from swallowing nitric acid, although none of it reached lower down than the pharynx; and though Ollivier doubts the accuracy of the statement, it appears reasonable to admit that such injury may be done to the glottis as will be adequate of itself to occasion death[†].—In a very interesting and carefully detailed case by *Mr Arnott* of the Middlesex Hospital, which has already been once or twice referred to, the injury was confined in a great measure to the gullet and larynx,—the stomach, which was distended with food at the time, being very little affected. The chief symptoms at first, besides great general depression, were croupy respiration and much dyspnœâ, on account of which laryngotomy was performed, and with complete relief to the breathing. But the patient nevertheless rapidly sunk under the symptoms of general exhaustion, and died in thirty-six hours without presenting any particular signs of the operation of the poison on the stomach; and the traces of action found there after death were trifling [‡].

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[*] Journal de Médecine par Corvisart, xix. 263.

[†] Rust's Magazin für die gesammte Heilkunde, xxiii. 156.

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[*] *Augustin's* Repertorium, i. ii. 15.

[†] Archives Gén. de Méd. xxi. 372, *note*.

[‡] London Medical Gazette, xii. 219.

In some circumstances the stomach seems to acquire a degree of insensibility to the action of the strong acids. Tartra, in alluding to what is said of certain whisky-drinkers acquiring the power of swallowing with impunity small quantities of the concentrated acids, has related the case of a woman at Paris, who, after passing successively from wine to brandy and from that to alcohol, at last found nothing could titillate her stomach except aqua-fortis, of which she was seen to partake by several druggists of veracity[*]. The fire-eating mountebanks too are said to acquire the same power of endurance; but much of their apparent endowments is really legerdemain. On the other hand, a very extraordinary sensibility to the action of the diluted mineral acids has been supposed to exist in the case of infants at the breast,—so great a sensibility, in fact, that serious symptoms and even death itself have been ascribed to the nurse's milk becoming impregnated with sulphuric acid, in consequence of her having taken it in medicinal doses. By two writers in the London Medical Repository griping pains, tremors and spasms have been imputed to this cause[†]; and a late writer in the Medical Gazette says he has seen continued griping, green diarrhœa and fatal marasmus ensue,—apparently, he thinks, from ulceration of the gastro-intestinal mucous membrane[‡]. Without questioning the great delicacy and tenderness of that membrane in infants, I must nevertheless express my doubts whether so small a quantity taken by a nurse, amounting in the cases in question only to four or six drops a day, could really produce fatal or even severe effects on her child.

The mineral acids are equally poisonous when inhaled in the form of gas or vapour as when swallowed; and they then act chiefly by irritating or inflaming the mucous membrane of the air-passages and lungs. For some observations on their effects in this form both on plants and animals the reader may refer to the Chapter on Poisonous Gases.

The sulphuric and nitric acids belong to the poisons alluded to under the head of General Poisoning,—of whose operation satisfactory evidence may be occasionally drawn from symptoms only. If immediately after swallowing a liquid which causes a sense of burning in the throat, gullet, and stomach, violent vomiting ensues, particularly if the vomited matter is mixed with blood; if the mouth becomes white or yellow, and stripped of its lining membrane, and the cheeks, neck, or neighbouring parts show vesications, or white, and subsequently yellow, or brown, excoriated spots;—if the clothes show red spots and are disintegrated there,—I cannot see any objection to the inference, that nitric or sulphuric acid has been taken. In this opinion I am supported by a good authority, Dr Mertzdorff, late medical inspector of Berlin*.

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[*] *Tartra*, p. 124.

[†] *Dr Bartley*, iv. 289, and *Mr Diamond*, v. 110.

[‡] *Mr Bevan*, i. 756.

SECTION III.—*Of the Morbid Appearances caused by the Mineral Acids.*

The outward appearance of the body in cases of Tartra's first variety is remarkably healthy; every limb is round, firm, and fresh-looking.

On the lips, fingers, or other parts of the skin, spots and streaks are found where the acid has disorganized the cuticle. These marks are brownish or yellowish-brown, and present after death the appearance of old parchment or of a burn; sometimes there are little blisters †.

The lining membrane of the mouth is more or less disorganized, generally hardened, whitish or yellowish with sulphuric acid, with nitric acid yellowish, more rarely whitish. The pharynx is either in the same state or very red or even swelled. The rima glottidis, as in the case described by *Dr Sinclair* and in that of *Mr Arnott*, is sometimes contracted, the epiglottis swelled, or on the contrary shrivelled, and the commencement of the larynx inflamed ‡. The gullet is often lined with a dense yellow membrane, adhering firmly, resembling the inner coat, but probably in general a morbid formation; and the subjacent tissue is brown or red. Sometimes, however, the inner coat or epithelion of the gullet loses its vitality, and is detached in part or altogether. In *Mr Arnott's* case the pharynx and upper gullet were lined by a pale lemon-coloured membrane, which in the lower two-thirds of the canal was completely detached and was plainly the œsophageal membrane; in the case related by *Mertzdorff*, the whole inner coat of the gullet, as well as that of the throat, epiglottis, and mouth, was stripped from the muscular coat; * and in another described by *Dr Wilson* of the Middlesex Hospital a portion of the lining membrane eight inches long, which I have had an opportunity of examining, was discharged by vomiting on the sixth day †. In a few rare cases of chronic poisoning with the mineral acids the gullet is found perforated by an ulcerative process ‡; but it is never perforated by their corrosive action in quickly fatal cases. Occasionally the gullet is not affected at all, though both the mouth and the stomach are severely injured; and an instance has even been published where the acid, in this instance the nitric, left no trace of its passage downwards till near the pylorus §.

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* *Horn's* Archiv für Medizinische Erfahrung, 1823, i. 465.

† *Horn's* Archiv, &c. 452.

‡ Edin. Med. and Surg. Journal, xxxvi. 101. Lond. Med. Gazette, xii. 221.

The outer surface of the abdominal viscera is commonly either very vascular or livid, or bears even more unequivocal signs of inflammation, namely effusion of fibrin and adhesions among the different turns of intestine; and these appearances may take place although the stomach is not perforated ‖. In this respect poisoning with the acids differs from the effects of most metallic poisons, which very seldom cause unequivocal peritonæal inflammation. I have, however, seen the peritonæum quite natural after death from sulphuric acid, even although the stomach was perforated. This was in a case fatal in twelve hours. The stomach, if not ruptured, is commonly distended with gases. It contains a quantity of yellowish brown or black matter, and is sometimes lined with a thick paste composed of disorganized tissue, blood and mucus. The pylorus is contracted.

The mucous membrane is not always corroded. If the acid is diluted, the coats may escape corrosion; but there is excessive injection, gorging, and blackness of the vessels, general blackness of the membrane, sometimes even without softening, as in a case related by *Pyl* of a woman who first took aquafortis and then stabbed herself ¶. More commonly, however, along with the blackness there is softening of the rugæ or actual removal of the villous coat, occasionally regular granulated ulceration with puriform matter on it [*]. The stomach is not always perforated. But if it is, the holes are circular, and the coats thin at the margin, coloured, disintegrated, and surrounded by vascularity and black extravasation. In some rare cases there is no mark of vital re-action except in the neighbourhood of the aperture. A case of this kind is related by *Mertzdorff*: The margin of the hole was surrounded to the distance of half an inch with apparent charring of the coats, and this areola was surrounded by redness; but the rest of the stomach was grayish-white [†]. I examined with the late *Dr Latta* of Leith a similar case, where the limitation of the injury was evidently owing to the stomach having been at the time filled with porridge. The patient, a child two years old, died in twelve hours; and on the posterior surface of the fundus of the stomach, towards the pylorus, there was a hole as big as a half crown, which was surrounded to the distance of an inch with a black mass formed of the disorganized coats, and of incorporated, charred blood. But the rest of the stomach was quite healthy. The perforation, if the patient lives long enough, is generally accompanied with a copious effusion into the belly of the usual muddy liquor of peritonitis; and the outer surface of the viscera feels unctuous, as if from a slight chemical action of the acid on them. The acid has actually been found in the contents poured out from the stomach into the sac of the peritonæum [‡].

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* Horn's Archiv, &c. 453.

† London Medical Gazette, xiv. 489.

‡ *Louis*, *Ibidem*, xiv. 30.

§ Philadelphia Journal of the Med. and Phys. Sciences, iv. 410.

‖ London Medical Gazette, viii. 76.

¶ Aufsätze und Beobachtungen, ii. 122.

One would expect to find the acid always in the stomach when it is perforated. Nevertheless it is sometimes almost all discharged. In *Mertzdorff's* case, that of an infant who was killed in twelve hours, a hole was found in the stomach ¾ths of an inch in diameter, and the contents of the stomach were effused into the belly: yet by a careful analysis the whole acid he could procure from the contents and tissues together was only 4½ grains.

The inner coat of the duodenum often presents appearances closely resembling those of the stomach. Sometimes, however, as in the case just related from Mertzdorff, and in the infant I examined, the inner coat of the small intestines is not affected at all, probably because in such rapid cases the pylorus retains a state of spasmodic contraction till death or even after it.

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[*] Archives Générales de Médecine, xiii. 368.

[†] Horn's Archiv, &c. 1823. i. 456.

[‡] Edin. Med. and Surg. Journal, xxii. 222. and xxxvi. 103.

The urinary bladder is commonly empty. The thoracic surface of the diaphragm is sometimes lined with lymph, indicating inflammation in the chest. In the case which was fatal in two hours, [p. 161,] *Professor Remer* found the surface of the lungs, as well as that of the liver and spleen, brown and of a leathern consistence, and the tissue beneath scarlet;—appearances which he thinks arose from the acid penetrating in vapour and acting chemically. I have not found this appearance mentioned by any other writer; but I have seen it in animals poisoned with oxalic acid. The blood in the heart and great vessels has been several times seen forming a firm black clot. *Kerkring* * relates an instance of the kind; in *Dr Latta's* case the appearance was very distinct; and I have observed it noticed in some other instances in the course of reading, the references to which I have unfortunately neglected to preserve. This state of the blood is not the effect of the particular poison, but its healthy state, and a striking appearance in contradiction to what is observed after death from most other poisons.

The general appearance of the body of those who have died of the Second or Chronic variety of poisoning with the acids, is that of extreme emaciation. The stomach and intestines are excessively contracted: The former has been found so small as to measure only two inches and a half from the cardia to the pylorus, and two inches from the lesser to the greater curvature †. Tartra says the intestines are sometimes no thicker than a writing quill. They are in other respects sound outwardly, except that they sometimes adhere together.

Internally the pylorus is contracted so as barely to admit a probe. There are spots over the stomach apparently of regenerated villous tissue, smoother and redder than the natural membrane. At the points where the stomach adheres to the neighbouring organs, its coats are sometimes wanting altogether, so that when its connections are torn away, perforations are produced. The other parts of the body are natural.

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* Kerkringii opera omnia, p. 146.

† *Robert* in Nouvelle Bibliothèque Médicale, 1827, iv. 415.

It may in some circumstances be necessary to determine from the appearances in the dead body whether a mineral acid has been the occasion of death or has been introduced into the body after death. This may always be easily done. If a few drachms of sulphuric acid be injected into the anus immediately after death, and the parts be examined in twenty-four hours, it will be found, that wherever the acid touches the gut, its mucous coat is yellowish and brittle, its muscular and peritonæal coats white, as if blanched, and the blood in the vessels charred; the injury is confined strictly to the parts actually touched, is surrounded by an abrupt line of demarcation, and shows no sign of inflammatory redness. Nitric acid produces nearly the same effects. The whole tunics are yellow, and the disorganization is greater. For these facts we are indebted to *Orfila* *.

In closing this account of the morbid appearances, some observations will be required on the force of evidence derived from them; because the nature of a case may be such as to exclude the other branches of the medical proof. In many instances both of acute and of chronic poisoning with the strong acids, I conceive, contrary to the general statements of most systematic writers on modern medical jurisprudence, that distinct evidence may be procured from the appearances only. Thus, what fallacy can intervene to render the following opinion doubtful? In a case several times alluded to as described by Mertzdorff there were vesicles and brown streaks on the lips, neck, and shoulders, similar to the effects of burning,—almost total separation of the lining membrane of the mouth, throat, epiglottis, and gullet,—perforation of the stomach with a margin half an inch wide, which was extensively charred, and surrounded by a red areola. From the appearances alone Mertzdorff declared that the child must have been poisoned with sulphuric acid. Perhaps he should have said sulphuric or nitric acid.

Or take the case of Richard Overfield, who was condemned at Shrewsbury Assizes in 1824 for murdering his own child, a babe three months old, by pouring sulphuric acid down its throat. In the dead body the following appearances were found: The lips were blistered internally and of a dark colour externally; the gullet was contracted and its inner coat corroded; the lining membrane of the mouth and tongue of a dull white colour; the great curvature of the stomach corroded and converted into a substance like wet brown paper; the stomach perforated and a bloody-coloured fluid in the sac of the peritonæum*. If to these appearances be added the fact that the child's dress was reddened, what is there to prevent the medical jurist from declaring, without reference to chemical evidence, that this case must have been one of poisoning with a mineral acid?

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* Toxicologie Générale, ii. 689.

In like manner in the case of Mrs Humphrey, who was condemned at Aberdeen in 1830 for murdering her husband by pouring sulphuric acid down his throat while he was asleep, there was found, on examining the dead body, two brown spots on the outside of the lips,—whiteness of the inside of the lips and of the gums,—glazing of the palate, redness, with here and there ash-coloured discoloration, of the uvula, posterior part of the throat, pharynx and epiglottis,—abrasion of most of the inner coat of the gullet,—erosion and dark-red ulceration of the inner coat of the stomach in winding furrows. When to these appearances it is added, that the man was in good health only forty-seven hours before death, and was taken ill suddenly and violently with burning pain in the throat and stomach †, it is not easy to see what other opinion could be formed of the case, unless that he died of poisoning with a mineral acid, and probably with sulphuric acid.

I am far from desiring to encourage rashness of decision or to revive the loose criterions of poisoning relied on in former times. But there cannot, in my opinion, be a rational doubt that these cases are distinct exceptions to the general law regarding the feebleness of the evidence from morbid appearances, and that a witness would certainly be guilty of thwarting the administration of justice, if, relying on general rules, he refused to admit similar exceptions. What natural disease could produce appearances like those described above? Assuredly no form of spontaneous perforation bears any resemblance to the two first; nor is it easy to mention any combination of natural diseases which could produce the peculiar conjunction of appearances remarked in the third.

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* Edinburgh Med. and Surg. Journal, xxii. 222.

† Ibidem, xxxv. 302.

SECTION IV.—*Of the Treatment of poisoning with the Mineral Acids.*

Since the mineral acids act entirely as local irritants, it may be inferred that their poisonous effects will be prevented by neutralizing them. But in applying that principle to the treatment it is necessary to bear in mind their extremely rapid operation; for if much time is lost in seeking for an antidote, irreparable mischief may be caused before the remedy is taken. Should it be possible then to administer chalk or magnesia without delay, these are the antidotes which ought to be preferred; but it may be well for the physician to remember, that in the absence of both he may at once procure a substitute in the plaster of the apartment beat down and made into thin paste with water. A solution of soap is another antidote of no small value. While the antidote is in preparation, the acid should be diluted by the free use of any mild fluid, milk or oleaginous matters being preferred. The carbonates of the alkalis are by no means eligible antidotes, being themselves possessed of corrosive properties. In a paper written lately on poisoning with the mineral acids by *Dr Lunding* of the Royal Infirmary at Copenhagen the author admits that he is disposed to ascribe the large proportion of deaths in his practice to the system pursued in that hospital of administering carbonate of potass as an antidote daily for weeks together,—a system which must certainly appear very irrational to the toxicologist*.—After the proper antidote has been given to a sufficient extent, the use of diluents ought to be continued, as they render the vomiting more easy. —Some have recommended and employed the stomach-pump for administering antidotes and diluents; but this is unnecessary. When it is wished to evacuate the stomach, there is an advantage in allowing it to do so by its own efforts, if possible, because the evacuation is accomplished more completely than it is possible to effect by the stomach-pump. Besides, if the patient cannot swallow fluids, still less can he suffer the tube of the stomach-pump to be introduced. On several occasions, indeed, it has been found impracticable to introduce it †.

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* Medizinisch-Chirurgische Zeitung, 1224, iv. 276.

† *Dr Sinclair.* Edin. Med. and Surg. Journal, xxxvi. 99; and Case of Humphrey. *Ibidem*, xxxv. 301.

The treatment of the supervening inflammation does not differ from that of the inflammation of the stomach. Where there is great difficulty of breathing, evidently from obstruction of the larynx, and where the absence of abdominal pain, tension or vomiting affords a presumption that little injury has been done to the stomach, laryngotomy appears an advisable remedy, and has been known to give very great relief*. But the patient may nevertheless die soon of the sympathetic disorder of the circulation.

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* London Medical Gazette, xii. 219. *Mr Arnott's* Case.

CHAPTER IV.

ON POISONING WITH PHOSPHORUS AND THE OTHER BASES OF THE MINERAL ACIDS.

Of Poisoning with Phosphorus.—The only other mineral acid that deserves mention is the phosphoric. It possesses properties nearly analogous, and hardly inferior to those of the three acids already mentioned. On its own account, however, it does not merit any notice here, since it is much too rare to be within reach of a person who intends to give or take poison. But it must be attended to, because it is formed in the course of the action of a more common poison, Phosphorus.

Orfila found that two drachms of phosphorus given to dogs in fragments caused death in twenty-one hours, that the whole stomach and intestines were more or less inflamed, and that the phosphorus had lost much of its weight, though vomiting had been prevented by a ligature on the gullet;—in fact the poison was partly oxidated. In a state of minute division, as when dissolved in oil, twenty-four grains caused death in less than five hours with all the symptoms of the most acute irritant poisoning; and after death the stomach was found extensively corroded, and perforated by two holes [*]. Other experimentalists have found that half a grain melted in hot water could kill a dog[†]; and that water, in which phosphorus had been simply received in the process for preparing it, proved in small quantities fatal to poultry [‡].

There is no doubt, therefore, that phosphorus is a dangerous poison to animals. Its effects on man have not been often witnessed; but the observations hitherto made will show that it is not less injurious to him than to the lower animals. A grain and a-half have actually proved fatal to man, as appears from a case mentioned by *M. Worbe*[§]. The subject of the case was a stout young man who took a grain and a-half in hot water, after having previously taken half a grain without sustaining injury.

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[*] Toxicologie Générale, i. 56.

[†] *Worbe* in Mémoires de la Société Médicale d'Emulation, ix. 507.

[‡] Annales de Chimie, xxvii. 87.

[§] *Worbe*, &c. and Edin. Med. and Surg. Journal, xxviii. 228.

In seven hours, and not till then, he was attacked with pain in the stomach and bowels, then with incessant vomiting and diarrhœa, excessive tenderness and tension of the belly,—all the symptoms in short of irritant poisoning; and he died exhausted in twelve days.—Another fatal case somewhat similar in its circumstances has been related by *M. Julia-Fontenelle*[*]. An apothecary after taking in one day first a single grain and then two grains of phosphorus without experiencing any particular effects, swallowed next day three grains at once in syrup. In the evening he felt generally uneasy, from a sense of pressure in the belly, which continued for three days; and then he was also seized with violent, continual vomiting of a matter which had an alliaceous odour. On the seventh day he had also spasms, delirium, and palsy of the left hand; and death speedily ensued. —In the only other case I have hitherto found recorded death took place in forty hours, and the symptoms were violent pain in the stomach, and continual vomiting, together with the discharge by clysters of small fragments of phosphorus, which were discovered by their shining in the dark, and subsequently by the appearance of burnt spots on the bed-linen. In this case, which is described by *Dr Flachsland* of Carlsruhe[†], the quantity of the poison taken was not ascertained. The patient, a young man, took it on bread and butter at the recommendation of a quack, to cure constipation, general debility, and impotence.

At one time it was the custom to give small doses of phosphorus in medical practice; but the uncertainty and occasional severity of its operation have perhaps properly expelled it from most modern pharmacopœias. Among other properties ascribed to it in medicinal doses, it was said to be a powerful aphrodisiac: No such symptom was remarked in the first of the fatal cases just related.

As to the morbid appearances, the same changes of structure may be expected as in the instance of the mineral acids generally. In Worbe's case quoted above, the skin was generally yellow, and here and there livid; the lungs gorged with blood; the muscular coat of the stomach inflamed, but the other coats not, except near the two extremities of the organ, where they were black. In Flachsland's case much fluid blood was discharged from the first incisions through the skin of the belly; the omentum and outside of the stomach and intestines were red; the villous coat of the stomach presented an appearance of gangrenous inflammation (probably black extravasation only); the inner membrane of the duodenum was similarly affected; the great intestines were contracted to the size of the little finger; the mesenteric glands enlarged; and the kidneys and spleen inflamed.

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[*] Revue Médicale, 1829, iii. 429.

[†] Medizinisch-Chirurgische Zeitung, 1826, iv. 183.

Phosphorous Acid, the effects of which have been lately examined experimentally by *Professor Hünefeld* of Greifswalde, differs in its operation from phosphoric acid. Twenty-five grains had no effect on a rabbit; but a drachm caused difficult breathing, restlessness, bloody vomiting, slight convulsions, and death in twelve hours; and the stomach was found not much injured. The urine contained phosphoric acid *.

Of poisoning with Sulphur.—It does not appear that sulphur, which resembles phosphorus in many particulars, bears any resemblance to it in physiological properties;—which may be ascribed to its not being susceptible of spontaneous acidification. It certainly possesses, however, slight irritating properties. It is often given as a purgative, which is sufficient to prove that it is not altogether inert; and the veterinary school at Lyons found that a pound killed horses by producing violent inflammation, recognizable during life by the symptoms, and after death by the morbid appearances †.

Of poisoning with Chlorine.—Chlorine in its gaseous state acts powerfully as an irritant on the windpipe and lungs, and on that account will be noticed under the head of the poisonous gases. But even in solution it retains to a certain degree its poisonous qualities. *Orfila* says that five ounces of a strong solution of chlorine will kill a dog in twenty-four hours, if it is kept in the stomach by a ligature, and that two ounces diluted with twice its volume of water will prove fatal in four days;—that the symptoms are those of irritation of the stomach;

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* *Horn's* Archiv. für Medizinische Erfahrung, 1830, ii. 861.

† *Corvisart's* Journal de Médecine, xxi. 70.

—and that in the former case he found general redness and blackness—in the latter ulceration of its villous coat *.

Of poisoning with Iodine.—*Iodine* is a poison of more consequence than chlorine, both because it is becoming a more common article, and because it is more violent in its effects on the animal economy.

Iodine when pure is a solid substance easily known by its brownish, scaly appearance, its peculiar odour, the violet fumes it forms when heated, and the fine blue colour it produces with a solution of starch.

When dissolved in water or in solutions of neutral salts, it communicates to the fluid a yellowish-brown or reddish-brown colour, which is destroyed by sulphuretted hydrogen. In the colourless fluid thus formed, if treated with a drop or two of sulphuric acid,—or in the original brown fluid without sulphuric acid,—a solution of starch, obtained by ebullition and subsequently cooled, produces a fine blue colour and precipitate; and these, if the solution be sufficiently diluted, disappear on boiling, reappear on sudden cooling, and are removed permanently by a stream of sulphuretted hydrogen. This is a very delicate and characteristic system of tests.

When mingled with organic substances, the discovery of it is a matter of some nicety. This subject has been examined with success by *Dr O'Shaughnessey*[†]. He first shows that by admixture with organic substances, especially in the alimentary canal during life, it quickly undergoes important changes, which must not be lost sight of in a medico-legal analysis. It unites with albumen, forming a substance nearly insoluble in alcohol, and also with fecula, forming the usual blue compound; if it has been also some time in the stomach it is converted into hydriodic acid by means of certain obscure vital operations; and this conversion takes place so quickly, that few cases can occur in medico-legal practice, where iodine will be discoverable in its free state. In addition to these sources of difficulty he has also remarked that where iodine exists in a free state in such mixtures starch may not act on it, because its particles are enveloped and protected by mucus or other organic matters;—and farther, that the starch may not present its characteristic action in consequence of the deep colour of the mixture.

[*] Toxicologie Générale, i. 141.

[†] Lancet, 1829-30, ii. 632.

These facts being kept in view, he suggests a new process for detecting iodine in such mixtures. [See Hydriodate of Potass, p. 184.] The following method of analysis, however, has appeared to me preferable.

Process for Compound mixtures. Add water if necessary, and filter. If either the fluid or solid part is little or not at all coloured, test it with cold solution of starch, assisting the action of the test on the solid part by trituration in a mortar. If a blue colour be struck, which disappears under ebullition, and reappears either under refrigeration alone, or on the subsequent addition of a drop of sulphuric acid, there can be no doubt of the existence of iodine.—If the colour of the suspected mixture after filtration is so deep that the action of the starch cannot be expected to yield characteristic appearances, then both the solid and fluid parts should be agitated with a third of their volume of ether; and after the etherial solution has risen to the surface, it is to be removed and tested with the solution of starch. The blue colour will be now perhaps struck, because the ether, in carrying off the iodine from the mixture, leaves many coloured organic principles behind.

Should free iodine not be thus detected, strong presumptive evidence may still be procured of its actual presence, or of its having been at one time present, by continuing the examination with the view to detect hydriodic acid. This is described in p. 182.

By following this method of analysis, I have found that one grain of iodide of potassium, which is equivalent to three quarters of a grain of iodine, may be easily discovered in six ounces of urine, which is as complicated a fluid as can well be conceived.

Iodine has a twofold action, one local and irritating, the other general, and produced only when it has been administered long in frequent small doses.

Orfila remarked that in doses of two drachms it excited in dogs symptoms of irritation in the stomach; that death slowly ensued in seven days, without the symptoms having ever become very violent; and that the villous coat of the stomach was here and there yellow, had also patches of yellow mucus lining it, and exhibited numerous little ulcers of a yellow colour.

An important circumstance in regard to the physiology and medical jurisprudence of this poison and its compounds is, that it may undoubtedly be detected in the blood of those who have used them for some time medicinally. It has been already observed, that *Cantu*, an Italian experimentalist, has discovered iodine in such circumstances in the blood, sweat, urine, saliva, and milk, and that *Bennerscheidt*, a German chemist, has also found it in the blood [p. 14.] In the latter instance it could not be detected in the serum, but it was detected in the crassamentum by means of starch. Some interesting facts of the same nature have also been lately ascertained by *Dr O'Shaughnessey*, from which it appears that even in acute poisoning with this substance, satisfactory proof of its administration may be procured several days afterwards by analyzing certain secretions. In a dog poisoned with iodine he detected the poison in forty minutes in the urine, and occasionally in the same secretion so late as the fifth day, on which day it died. It is singular, however, that he could not find it in the same quarter on the third day, although it existed at that time abundantly in the saliva *. In these experiments the iodine was always found to be in the form of hydriodic acid, having been converted into that compound in the alimentary canal in the way formerly mentioned. This change takes place with such rapidity, that on one occasion, in the vomited matter discharged by a dog fifteen minutes only after the administration of iodine, Dr O'Shaughnessey could find no iodine, but a large quantity of hydriodic acid †.

Considerable uncertainty prevails as to the circumstances in which we may expect iodine to be detected in the organs or secretions of persons who have taken it. Thus it has been stated by an Italian physician, *Dr Cristin*, that in very many individuals affected with dropsy, struma, epilepsy, and other diseases, he had sought for iodine to no purpose in the urine, bronchial mucus, and other excretory fluids ‡.

With regard to its operation on man, *Orfila* says, he has tried the effects of four or six grains on himself, and that he found this dose produce a sense of constriction in the throat, sickness, pain in the stomach, and at length vomiting and colic. There is no doubt, therefore, that in larger doses it will prove a dangerous irritant to man as well as to dogs. Accordingly *Dr Gairdner* has noticed the case of a child four years old, who died in a few hours after taking about a scruple in the form of tincture[*]; but he has not mentioned the symptoms. *Dr Jahn* of Meiningen mentions a case where an over-dose produced violent pain in the belly, vomiting, profuse bloody diarrhœa, coldness and blanching of the skin, rigors, quivering of the sight and rapid pulse[†]. Two similar cases are related in a recent French journal; in one, which was produced by a drachm and a half of the ioduretted solution of hydriodate of potass, nausea, with acute pain and sense of burning in the pit of the stomach, followed immediately; in an hour there was vomiting of a yellowish matter which had the taste of iodine; excessive restlessness ensued, with headach, giddiness and paleness of the countenance; and these symptoms were not entirely dissipated for five days[‡]. In the other case two drachms and a half of iodine were swallowed for the purpose of self-destruction. A sense of dryness and burning from the throat down to the stomach were immediately produced; lacerating pain in the stomach and fruitless efforts to vomit succeeded; and in an hour, when the relater of the case first saw the patient, there was suffusion of the eyes, excessive pain and tenderness of the epigastrium, and sinking of the pulse. Vomiting, however, was then brought on by warm water; copious yellow discharges, possessing the smell and taste of iodine, took place; and in nine hours the patient was well[§].

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* *Lancet*, 1830–31, Vol. i. 613.

† *Ibidem*, 612.

‡ Prospetto Clinico, p. 19. *from* Annali Univ. et Med. 1833.

It further appears that in medicinal doses, such as a quarter of a grain, frequently repeated, it is a dangerous poison, unless its effects are carefully watched. For in consequence of absorption and accumulation in the system, it produces when long used some very singular and hazardous symptoms; and like mercury, foxglove, and some other poisons, it may remain in the body for a considerable period inactive, and at length begin to operate suddenly. The symptoms which it then occasions are sometimes those of irritation; namely incessant vomiting and purging, acute pain in the stomach, loaded tongue, rapid and extreme emaciation, violent cramps and small frequent pulse.

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[*] Essay on the effects of Iodine, 1824, p. 20.

[†] *Horn's* Archiv fur Medizinische Erfahrung, 1829, i. 340.

[‡] *Dessaigne* in Journal de Chim. Médicale, iv. 65.

[§] *Moncourrier*. *Ibidem.* iv. 216.

These symptoms may continue many days, and even when subdued to a certain extent, vomiting and cramps are apt to recur for months after [*]. A fatal case of this form of affection has been related by *M. Zink*, a Swiss physician. His patient, after taking too large doses of iodine for about a month, was seized with restlessness, burning heat of skin, tremors, palpitation, syncope, excessive thirst, a sense of burning along the gullet, frequent purging of bilious and black stools, priapism, and tremulous pulse. The symptoms of local inflammation went off in a few days; but those of general fever continued; and he died after six weeks' illness [†]. Another fatal case has been described in Rust's Journal. The leading symptoms were pain in the region of the liver, loss of appetite, emaciation, quartan fever, diarrhœa, excessive weakness; and after the emaciation was far advanced a hardened liver could be felt. The patient appears to have died of exhaustion [‡]. From this case, and another of which the appearances after death will be presently noticed, it is not improbable that iodine possesses the power of inflaming the liver.—In another and more common affection, the patient is attacked with tremors, at first slight and confined to the fingers, afterwards violent and extending to the whole muscles of the arms and even of the trunk. At the same time there is excessive and rapidly increasing weakness, a sense of anxiety, sinking and faintness, a total suspension of the function of digestion, rapid and extreme muscular emaciation, tendency to fainting, and violent continued palpitation [§], accompanied not unfrequently with absorption of the mammæ if the patient is a female. In the midst of these phenomena the curative powers of the poison over the disease for which it has chiefly been used, namely goître, are developed. It has been remarked in particular, that the diminution of the goître keeps pace with the diminution of the breasts, though at times either effect has been developed without the other. An instance is related in Rust's Journal of a female, whose breasts began to sink after she had used iodine for four months; and in four weeks hardly a vestige of them remained; but her goître was not affected [‖].—An

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[*] *Gairdner* on the effects of Iodine, p. 9.

[†] *Journal* Complémentaire, xviii. 126.

[‡] *Magazin* für die gesammte Heilkunde, xvi. 111.

[§] *Gairdner*, &c. p. 12.

[‖] *Magazin* für die gesammte Heilkunde, xxii. 291.

American physician, *Dr Rivers*, has twice noticed barrenness apparently induced by the prolonged use of iodine; and as in these instances the females were young and previously very prolific, but ceased to bear children from the time the iodine was used, his observations seem worthy of attention[*].—*Dr Jahn*[†] specifies among the leading effects of the poison when slowly accumulated in the body,—absorption of the fat,—increase of all the excretions,—dinginess of the skin, with frequent, clammy sweat,—hurried anxious breathing,—diuresis and an appearance of oil floating in the urine,—increased discharge of fæces, which are unusually bilious, but free of mucus,—increased secretion of semen,—increased menstrual discharge,—swelling of the subcutaneous veins and lividity of the lips,—feebleness of the pulse, with superabundance of serosity in the blood,—impaired digestion and diminished secretion of saliva and mucus. This affection, which, in conformity with the name he has given it, may be termed Iodism [*Iodkrankheit*], he contrasts with mercurialism, the constitutional effect of the accumulation of mercury in the body; and he considers the former not more unmanageable than the latter.—The doses required to produce these effects are very various. Some people appear almost insensible to its action; in one instance, nine hundred and fifty-three grains were taken in daily portions varying from two to eighteen grains, without any bad effect [‡]; and *Magendie* once swallowed a scruple in the form of tincture without suffering any inconvenience [§]. On the other hand, *Dr Gairdner* has seen severe symptoms commence when no more than half a grain was taken three times a day for a single week [‖]; and *Coindet* has seen bad effects from thirty drops of the solution of ioduretted hydriodate taken daily for five days [¶].

The only account I have seen of the appearances left in the body after death from slow poisoning with iodine is contained in the essay of Dr Zink. In a second fatal case which came under his notice he found enlarged abdomen from distension of the intestines with gases, enlargement of the other viscera and serous effusion into the peritonæum; adhesion of the viscera to one another; redness of the intestines, in some places approaching to gangrenous discoloration; redness and excoriation of the peritonæal coat of the stomach, and also of its villous coat; enlargement and pale rose-red coloration of the liver. In the chest serum was found in the sac of the pleura. The gullet was contracted in diameter and red internally.

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[*] American Journal of Medical Science, viii. 546.

[†] Archiv für Medizinische Erfahrung, 1829, i. 342.

[‡] *Johnson's* preface to his Translation of Coindet on Iodine, p. ix.

[§] Formulaire pour les Nouveaux Medicamens, 161.

[‖] Gairdner, p. 20.

[¶] Coindet on Iodine, p 17.

Hydriodate of Potass.—To these remarks on iodine a few observations may be added on the hydriodate of potass, one of its compounds, which is now very generally substituted in medicine for the simple substance. The tests and actions of this poison have been examined by *M. Devergie*; and more lately its medico-legal chemistry has been investigated by *Dr O'Shaughnessey*.

It is sold in the shops of various degrees of purity. Very pure hydriodate of potass is in white crystals, tending to the cubical form, permanent in the air, possessing a faint peculiar odour, and easily soluble in both water and alcohol. Another variety has the same form, but possesses a strong odour of iodine, is often yellowish in colour, and deliquesces slightly in moist air. This contains an excess of iodine, but in general is otherwise pure. A third common variety, which has been thrown in large quantity into the English market by the cupidity of a manufacturing company, is extremely impure. It presents no tendency to assume any crystalline form, is very deliquescent, dissolves but partially in alcohol, and effervesces strongly with acids. The principal ingredient in this article is carbonate of potass; and sometimes the proportion of hydriodate is very inconsiderable. In one specimen I procured 74.5 per cent. of carbonate of potass, 16 of water, and only 9.5 of hydriodate of potass. Others have also had occasion to remark the frequent impurity of this salt *.

In the solid state the hydriodate of potass may be known by the effect of strong sulphuric acid, which turns it brown with effervescence, and when aided by heat disengages violet fumes of iodine.

In solution many tests will detect it, such as sulphuric acid, corrosive sublimate, acetate of lead, protonitrate of mercury, muriate of platinum, and starch with sulphuric acid. Sulphuric acid forms a brown or orange-coloured solution by disengaging the iodine. Corrosive sublimate forms a fine carmine-red precipitate, the biniodide of mercury. Acetate of lead throws down a fine yellow precipitate, the iodide of lead. Protonitrate of mercury precipitates the protiodide of mercury, in the form of a yellow powder, which gradually fades into a dirty-brown. Muriate of platinum produces a brown precipitate, the iodide of platinum, and in very diluted solutions a brown coloration. Solution of starch, with a drop or two of sulphuric acid, strikes a deep blue colour, which, if the fluid is sufficiently diluted, disappears on boiling, reappears on sudden cooling, or subsequently on the addition of a drop of sulphuric acid, and is permanently removed by a stream of sulphuretted hydrogen gas. Of these tests the most characteristic is the solution of starch; and it is also extremely delicate.

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* See *Dr O'Shaughnessey's* paper in Lancet, 1829-30, ii. 637.

In compound mixtures most and sometimes all of these tests are useless. If the mixture is deeply coloured, none will act characteristically. If carbonate of potass be present in such proportion as is often met with in the shops, the only test which acts characteristically is the infusion of starch.

Process for compound mixtures.—The following method of analysis is applicable to all mixtures, organic and inorganic.—Add water, if necessary, and filter; and if the fluid which passes through is tolerably free from colour, test a little of it with sulphuric acid and solution of starch. If the colour is too deep to admit of this trial, or the test on trial does not act, unite the fluid and solid parts and transmit sulphuretted hydrogen to convert any free iodine into hydriodic acid. Drive off the excess of gas, supersaturate with a considerable excess of potass, filter, and evaporate to dryness. Char the residue at a low red heat in a covered crucible; pulverize the charcoaly mass, and exhaust with water. This solution will probably act characteristically with starch and sulphuric acid; but on the whole it is better in the first instance to remove some of the salts by evaporating to dryness, and exhausting the residuum with alcohol. The alcoholic solution contains the hydriodate of potass, with some other salts; and on being evaporated to dryness, a residuum is left, on which, when dissolved in water, the starch and sulphuric acid will act characteristically. No other test is necessary; and frequently no other test will act, on account of co-existing salts.

I have found that a grain of hydriodate of potass may thus be easily detected in six ounces of urine, which must be considered a very complicated fluid. In the solution ultimately procured sulphuric acid struck a pale brown tint, and on the addition of solution of starch a dark-blue precipitate was formed; which, after being sufficiently diluted, disappeared under ebullition, leaving a colourless fluid. On cooling, no change took place; but on the subsequent addition of a drop of sulphuric acid, the blue colour and precipitation were immediately restored. No other reagent, not even the chloride of platinum, acted characteristically, although there was a sufficient quantity of solution to try the starch test ten times at least.

A different method has been proposed by *Dr O'Shaughnessey*, as follows.—Filter the suspected mixture, if necessary. Test the fluid and solid parts for free iodine, by means of the starch solution alone. If it does not act, transmit sulphuretted hydrogen; expel the excess of gas; and filter. To the filtered fluid add muriate of platinum; and if the colour produced be not as deep as that of port wine, evaporate to one-half before adding the salt of platinum to the whole. Then, to collect the iodide of platinum, which may remain suspended in organic fluids, agitate the whole with a third of its volume of sulphuric ether in a phial, and after a few minutes rest, remove the supernatant etherial solution, which contains all the iodide and has a brown colour. Evaporate the etherial solution to dryness, and test the residue first by heating it in a tube, by which means the blue vapour of iodine will be produced, and secondly by dissolving what sublimes in alcohol, and applying the test of solution of starch [*]. In this way Dr O'Shaughnessey thinks small proportions of hydriodate of potass may be detected with certainty in all kinds of fluids. But I apprehend, that there are many compound mixtures in which the first step, precipitation with muriate of platinum, may be troublesome on account of the great proportion of animal principles in solution,—while in the subsequent step the ether must take up certain vegetable and animal matters which may interfere materially with the sublimation of the residue procured by evaporating the etherial fluid. Dr

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[*] Lancet, 1829–30, ii. 685.

O'Shaughnessey, however, found the process succeed with six ounces of urine containing one grain, or about a 3000th, of hydriodate of potass *.

From the experiments of Devergie on animals, hydriodate of potass seems to be in large doses an irritant, though not a powerful one. Two drachms in an ounce of water killed a dog in three days with violent vomiting, and signs of irritation were found in the stomach, namely black extravasated spots and ulcers in the middle of them. A solution injected into the cellular tissue caused only local inflammation. Injected into the jugular vein in the dose of four grains, it produced tetanus and death in a minute and a-half †.

In regard to the effects of hydriodate of potass on man, we are not acquainted with the symptoms produced by single large doses; but it appears to be established by some important researches in France, that the long-continued use of it in small doses with the food may produce serious derangement of the health,—swelling of the face, headach, urgent thirst, inflammation of the throat, violent colic pains, and frequently bloody diarrhœa. A disease characterized by the symptoms now described has of late appeared repeatedly as an epidemic in various parts of France, and spread so widely in one parish, that not less than a sixth of the whole population were attacked. After several careful investigations, it seems to have been fully proved, that the affection was owing to the use of salt fraudulently adulterated with an impure salt, obtained from kelp after the separation of the carbonate of soda, and consequently impregnated with an appreciable proportion of hydriodate of potass ‡.

I am not acquainted with any other cases of poisoning with this substance in the human subject. It is believed to have the same power as iodine over goître, and not to be so apt to injure the stomach and constitution. Should a case of poisoning with it ever occur, where a medico-legal examination is required, it is important to remember that it may be often detected in the urine several days after it was swallowed, at which time its de-

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* Lancet, 1829–30, ii. 638.

† Archives Générales de Médecine, x. 255.

‡ This adulteration and its effects have been indicated by various chemists. For the best account, see *Chevallier*, sur les falsifications qu'on fait subir au sel marin, Annales d'Hyg. Publ. et de Méd. Lég. viii. 250. At one time he found about a third of the salt in Paris thus sophisticated.

tection in the alimentary canal or in vomited matters must be next to impossible. This interesting fact has been clearly proved by the researches of *Wöhler*[*] and *Stehberger*[†], and also by those of Dr O'Shaughnessey mentioned above under the head of iodine.

Of Poisoning with Bromine.—This singular substance is not an object of much interest in relation to medical jurisprudence, because it is rare, and only to be met with in the laboratory of the chemist. Hence, although it appears to be a poison of some activity, it is unnecessary to dwell on it particularly.

It is easily known from all other substances by its fluidity, its great density, which is thrice as great as that of water, its reddish-brown colour by reflected, and blood-red colour by transmitted light, the orange fumes which occupy the upper part of a bottle partly filled with it, and its intensely acrid, suffocating vapour, which is so powerfully irritating that an incautious inhalation is followed by all the phenomena of severe coryza and catarrh. Its odour, however, apart from its acridity, is very far from being so disagreeable as its discoverer in naming it seems to have imagined. In its properties it bears a close resemblance to chlorine and iodine.

The toxicological effects and medico-legal relations of Bromine have been examined by *M. Barthez*[‡], *Dr Butske*[§], and *Dr Dieffenbach*[||].

M. Barthez has given the following process for detecting bromine in compound mixtures, such as the contents of the stomach or vomited matter. First separate the fluid matter by filtration, and subject it to the action of chlorine, which will produce a fine orange-colour. Should this effect not result, or the change of colour be obscured by the deep tint of the fluid, treat the solid matter with solution of caustic potass; filter and add what passes through to the former fluid; evaporate to dryness and char by a red heat; act on the residue with distilled water.

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[*] *Zeitschrift* für Physiologie, ii.

[†] *Ibidem.*

[‡] *De l'Action du Brôme et de ses combinaisons sur l'économie animale.* Thèse Inaug. à Paris, 1828.

[§] *Hufeland's* Bibliothek der Praktischen Heilkunde, Sept. 1829; or Archives Générales de Méd. xxiv. 289.

[||] *Meckel's* Archiv. für Anatomie und Physiologie, xiv. 222.

The solution contains the hydrobromate of potass, and is therefore turned orange-red by chlorine. The orange tint, whether struck at once in the fluid part of the mixture, or after carbonization and solution of the residue, is removed by agitation with ether; and the etherial solution of bromine in its turn loses colour when treated with solution of caustic potass, hydrobromate of potass being again formed.

M. Barthez found, that ten or twelve grains dissolved in a sufficient quantity of water, and injected into the jugular vein of a dog, sometimes occasioned immediate death, preceded merely by a single fit of tetanic convulsions; and that on examining the body immediately afterwards the heart was seen gorged with clotted blood. He remarked, however, that six drops, or even twelve, or seventeen drops, did not always prove fatal, the symptoms produced being merely restlessness, difficult breathing, dilated pupil, frequency of the pulse, and sneezing. *Dieffenbach* remarked similar effects in the rabbit: The animals either died immediately, or soon recovered altogether. In a cat, after the injection of twelve drops of a concentrated solution into its jugular vein, death took place in fifteen minutes; but in another from which a little blood was drawn after the symptoms were fully formed, complete recovery gradually ensued. *Butske* found a horse suffer so much from mortal prostration immediately after five grains dissolved in two ounces of water were injected into its jugular vein, that he supposed it was about to die; but it quickly revived, and ultimately got quite well.

When introduced into the stomach of dogs, M. Barthez found that twenty drops on a full stomach had no particular effect; that thirty drops occasioned vomiting, and temporary acceleration of the pulse and breathing; and that from forty to sixty drops on an empty stomach brought on violent vomiting, sneezing, cough, dilated pupil and prostration, that in a few hours no symptom but languor remained, and that without any particular change death ensued in four or five days. In the dead body he remarked numerous little ulcers of the villous coat, some of which had an ash-gray appearance at the bottom, while others were covered with a black slough, easily removed by friction. When the gullet was tied to prevent vomiting, less doses proved more quickly fatal. He likewise observed that the matter vomited in these experiments, even a few minutes after the administration of the poison, had no appearance or odour of bromine; whence it is reasonable to conclude, that, as in the instance of iodine, a chemical change takes place with the aid of certain vital operations, so that the bromine becomes hydrobromic acid.—The experiments of Dr Butske assign to it more activity as a poison than those now related. For he found that a dog died in a day from taking only five grains dissolved in two ounces of water; and the symptoms were laborious breathing, loud cries, and convulsions. In the dead body he found the stomach internally chequered with bloody extravasation, and filled with bloody mucus, the duodenal mucous membrane universally injected, but the rest of the alimentary canal in the healthy state.

The only observations I have seen on the effects of bromine on man are a few experiments made with small doses on himself by the last experimentalist. He found that a drop and a half in half an ounce of water produced a sense of heat in the mouth, gullet, and stomach, and subsequently colic pains; and that two drops and a half in an ounce of mucilage excited, in addition to the preceding symptoms, great nausea, hiccup, and increased secretion of mucus. On the whole, there is no doubt that bromine is an active poison; and so far as may be judged from what is hitherto known, it is a pure local irritant. It appears to act most energetically when most thoroughly dissolved in water.

The *Hydrobromate of Potass* in the dose of half a drachm in solution, produces, according to Barthez, dulness and depression in dogs, but no other bad effect. Two drachms retained in the stomach by tying the gullet occasioned death in three days with symptoms of irritant poisoning

CHAPTER V.

OF POISONING WITH ACETIC ACID.

Acetic acid, although in its ordinary state undoubtedly possessed of little activity as a poison, has nevertheless been lately proved to be in some circumstances deleterious, and capable of occasioning death even in the human subject. It exists in various forms. The most common is ordinary vinegar, in which it is much diluted. Another common form is the pyroligneous vinegar, pyroligneous acid, or pyroligneous acetic acid, as it is variously called, which when impure has a reddish-brown colour, but when pure is almost or altogether colourless, and the strength of which is much greater than that of common vinegar. What is called Proof vinegar has a density about 1005, and 100 parts dissolve about five of pure carbonate of lime. The pyroligneous acid sold in the shops of this town, I find, has a density about 1024, and 100 parts dissolve 10 of carbonate of lime; but the pyroligneous acid of the London Pharmacopœia is stronger still, for its density is said to be 1046, and 100 parts dissolve 30 of carbonate of lime. A third form is the concentrated or pure acetic acid of the apothecary, which is familiarly known as the chief ingredient and menstruum of a common perfume, the aromatic vinegar.

Section I.—*Of the Tests for Acetic Acid.*

In all its forms acetic acid is easily known by its very peculiar odour, together with its acid reaction on litmus. But if farther evidence of its nature be required, it will be requisite to neutralize the fluid suspected to contain it with carbonate of potass, and then to procure the acetate of potass by evaporation. This salt is known by its extreme tendency to deliquesce, and by a concentrated solution in water, yielding, when distilled with sulphuric acid, a fluid possessing the peculiar odour and pungency of concentrated acetic acid.

When in a state of compound admixture with organic substances, such as the contents of the stomach, it has been proved by the late researches of *Orfila*[*], that this acid may be present in considerable proportion without distinctly reddening litmus, or causing effervescence with carbonate of lime. For such mixtures the following process of analysis, devised by the Parisian professor, will be found convenient and effectual. The fluid being put into a retort with a receiver attached, the retort is to be immersed in a concentrated solution of muriate of lime, which is to be heated in an iron pot or other convenient vessel to ebullition. In this way the fluid in the retort may be evaporated to dryness, without any charring of the organic matter. The distilled fluid may then be tested tentatively for sulphuric and muriatic acids; and these being proved to be absent, the acidity and peculiar smell of the liquid will supply strong presumption of the presence of acetic acid. This presumption may be turned to certainty by forming acetate of potass, as already directed for the pure diluted acetic acid.

Orfila has omitted in his paper a serious fallacy to which this, as well as every process for the detection of acetic acid in the contents of the stomach is exposed,—namely, that the natural secretions of the stomach, according to the researches of many physiologists, but more especially in recent times those of *Tiedemann and Gmelin*[†] in Germany, and those of *Leuret and Lassaigne* in Paris, frequently contain a small proportion of acetic acid. Hence, the inference in favour of the introduction of acetic acid into the stomach from without, founded on the process related above, is only legitimate when the quantity discovered is considerable.—The medical jurist ought also to keep in mind that vinegar is a common remedy with the vulgar for many diseases, and especially for poisoning.

SECTION II.—*Of the effects of Acetic Acid on Man and Animals.*

In the first edition of this work, it was stated that acetic acid could scarcely be considered a poison. And in illustration, a case was mentioned which fell under my own notice,—that of a gentleman, who during dinner swallowed at a draught about eight ounces of vinegar by mistake for beer, and who nevertheless sustained no harm although he retained it all, and as the only measure of precaution, swallowed after it an equal quantity of port wine. In farther confirmation of what is here mentioned, it may be added, that an ounce of acid equal in strength to the pyroligneous vinegar, but consisting of the pure concentrated acid diluted with water, has been found by *Schubarth* of Berlin, to produce very little effect when administered to a dog. The animal merely frothed a little at the mouth; cried and became restless for a time; then had one or two attacks of vomiting; and in an hour appeared quite well again[*]. Nay, it has even been found by *Pommer* of Heilbronn, that a considerable quantity of diluted acetic acid may be injected into the blood without causing any mischief. He injected six drachms of distilled vinegar into the femoral vein of one dog, and an ounce into the jugular vein of another, but observed no effect whatever, except slight labour of respiration for a short time afterwards[†].

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[*] Annales de Hygiène Publ. et de Méd. Lég. vi. 169.

[†] See above, p. 144.

It appears, however, from some late experiments performed by *Professor Orfila* on occasion of a judicial case to be mentioned presently, that all the forms of acetic acid will prove injurious and even fatal to dogs if given in sufficient quantity and prevented from being discharged by vomiting. An ounce of pyroligneous vinegar, administered to dogs of middle size, and retained in the stomach by a ligature on the gullet, produces efforts to vomit, evident suffering, prostration of strength, and death in five, seven, or nine hours. An ounce of concentrated acetic acid occasioned death in one hour and a quarter; and four or five ounces of common vinegar proved fatal in ten or fifteen hours. These experiments would make it appear that acetic acid is scarcely less active as an irritant poison than even the mineral acids[‡]. They are in some measure confirmed by the prior experiments of *Schubarth*; who operated, however, with an impure reddish-brown pyroligneous acid, and was led to ascribe its energy to the presence of some empyreumatic oil, because he found, as was already remarked, that a pure acid of equal strength appeared almost inert. From half an ounce to an ounce of the impure acid given to dogs, caused fruitless efforts to vomit, sometimes free vomiting, occasionally great flow of tears, always weakness in the hind-legs, and feeble, irregular pulse, and death either in two days without any new symptom of consequence, or more rapid death in four or five hours, with previous convulsions, and sometimes insensibility[*]. These experiments were made with an acid which neutralized 50 grains of carbonate of lime per ounce, consequently contained 50 grains of concentrated acid, or about a tenth of its weight[†], and was of the same strength with the acid sold in Edinburgh.

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[*] Beiträge zur Kentniss der Wirkungen der Arzneimittel und Gifte. *Horn's* Archiv. 1824, i. 59.

[†] Medizinisch-chirurgische Zeitung, 1828, ii. 256.

[‡] Ann. d'Hyg. Publ. et de Méd. Lég. vi. 160.

To these observations it may be added, that according to the experiments of *Hébréart*, a small quantity of acetic acid dropped into the windpipe, produces hissing respiration, rattling in the throat, and death in three days from true croup[†].

In all the preceding experiments distinct evidence was obtained in the dead body of the irritant action of the poison. The stomach contained brownish-black blood, the villous coat was blackish, and the subjacent cellular tissue injected with black blood; sometimes there was an appearance of erosion on the surface of the villous coat; and in the instance of the concentrated acid perforations were found. In the experiments of Hébréart the lining membrane of the windpipe was covered with a fibrinous pseudo-membrane, exactly as after croup.

Although acetic acid in its various forms is daily in the hands of every body, one case only of poisoning with it in the human subject has hitherto been made public. It is described by *MM. Orfila* and *Barruel*[‡]. A girl was seen in a village near Paris at eleven at night apparently intoxicated. Five hours afterwards she was found lying on the ground in great agony; and after complaining of pain in the stomach and experiencing several attacks of convulsions, she expired. On the subsequent examination of the body considerable lividity was observed on the skin of the depending parts. The back of the tongue was brownish and leathery, and the inner membrane of the gullet blackish-brown, intersected by a fine net-work of vessels. The stomach presented internally several large, black, firm elevations, owing to the injection of coagulated blood into the submucous cellular tissue; and elsewhere it had a grayish-white tint, with here and there a reddish colour; but the mucous membrane was perfectly entire. The cavity contained above eight ounces of a thick, blackish fluid; and a thicker pulpy matter of the same colour adhered firmly to the villous coat. The intestines were healthy, and so also were the other organs in the belly and chest. The uterus contained a fœtus two months and a half old. The contents of the stomach were subjected to a careful analysis by *MM. Orfila* and *Barruel*, who found that they did not contain any appreciable quantity of free sulphuric or muriatic acid, or of any of the common metallic poisons; and by the process of analysis formerly described they succeeded in separating from the impure mass three drachms of a pure, and tolerably concentrated acetic acid, besides two drachms more from the contents of the intestines. As the residue of the distillation left behind in the retort did not yield any bitter principle to boiling alcohol, so as to countenance the idea of a vegetable alkaloid having been given along with the acetic acid, they inferred that this acid had been swallowed alone; and the experiments of Orfila on dogs performed for the occasion, induced them to conclude that it was the cause of death.

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[*] Beiträge, &c. *Horn's* Archiv, 1824, i. 56.

[†] *Corvisart's* Journ. de Médecine, xxiv. 215.

[‡] Annales d'Hyg. Pub. et de Méd. Lég. vi. 159.

To these observations it is only farther necessary to add, that the concentrated acid is a powerful irritant and even corrosive when applied externally; which properties are owing to its power of dissolving many of the soft animal solids[*].

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[*] See Trousseau and Blanc, Arch. Gén. de Méd. Sept. 1830.

CHAPTER VI.

OF POISONING WITH OXALIC ACID.

The last poison of this order is Oxalic Acid. It is a substance of very great interest, for of late years it has caused death in our own country more frequently perhaps than any other variety of poisoning.

It was first introduced to the notice of the physician as a poison by *Mr Royston* in 1814[*], in consequence of its having been taken by mistake for Epsom salt;—a mistake which has apparently become more frequent since people were put on their guard against it. Now that its properties are familiarly known, it is often resorted to for committing suicide; for which purpose, indeed, the certainty and rapidity of its operation render it superior to all ordinary poisons. It is certainly ill adapted for the purposes of the murderer; for although it might be easily given to a sick person instead of a laxative salt, yet its real nature would betray itself too soon and too unequivocally for the chief object of the poisoner,—secresy. Nevertheless, at least one attempt of the kind has been made. At the trial of James Brown for assaulting his wife, held at the Middlesex Autumn Assizes 1827, it was brought out in evidence that he had previously tried to poison her by giving her oxalic acid in gin[†].

Its properties have been examined by Dr A. T. Thomson of London[‡], and Dr Perey of Lausanne[§]; in 1823, the whole subject of poisoning with oxalic acid in its medico-legal relations was examined by Dr Coindet of Geneva and myself[||]; and in 1828 another experimental inquiry, which confirms most of the results we obtained, was published by *Dr Pommer* of Heilbronn[¶].

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[*] London Medical Repository, i. 382.

[†] London Courier, September 22, 1827.

[‡] London Medical Repository, iii. 382.

[§] Dissertatio Inauguralis de Acidi Oxalici vi venenata, Edin. 1821.

[||] Edinburgh Med. and Surg. Journal, xix. 163.

[¶] Medizinisch-Chirurgische Zeitung, 1828, ii. 203, *et seq.*

SECTION I.—*Of the Tests for Oxalic Acid.*

Oxalic acid is commonly in small crystals of the form of flattened six-sided prisms, transparent, colourless, free of odour, very acid to the taste, and permanent in the air. Two other common vegetable acids, the citric and tartaric acids, differ from the oxalic in being seldom regularly crystallized and never in fine prisms. In general appearance it closely resembles the sulphate of magnesia, for which it has been so often and so fatally mistaken. So close, indeed, is the resemblance, that repeatedly, on desiring several persons to point out which was the poison and which the laxative, I have found as many fix on the wrong as on the right parcel. The sulphate of magnesia has of course a very different taste, being strongly bitter. Various plans have been devised for preventing the accident to which this unlucky resemblance has given rise. The best of them imply the use of a criterion or safeguard by the patient before he takes his laxative draught. It seems to have escaped the notice of those who have proposed the plans in question, that, if accidents are to be prevented in this manner, by far the simplest and most effectual security will be to let the public know that a laxative salt ought always to be tasted before it is swallowed. Its solubility has been much overrated by chemists. *Thenard* and others say it is soluble in twice its weight of temperate water; but it does not appear to me soluble in less than eleven parts.

In determining the medico-legal tests for oxalic acid, it will be sufficient to consider it in two states,—dissolved in water,—and mixed with the contents of the stomach and intestines or vomited mater. If the substance submitted to examination is in the solid state, the first step is to convert it into a solution.

1. In the form of a pure solution, its nature may be satisfactorily determined by the following process.

The acidity of the fluid is first to be established by its effect on litmus paper.—A small portion is next to be tested with ammonia, which, if the solution of the acid be sufficiently concentrated, will produce a radiated crystallization, as the oxalate of ammonia formed is much less soluble than oxalic acid itself. This property according to Dr O'Shaughnessey, distinguishes it from every other acid*.—The remainder of the fluid is next to be subjected to the following re-agents. These might be applied at once. But it is better to neutralize the acid previously with any alkali; for then they act with greater delicacy. The remainder of the process consequently applies not only to oxalic acid itself, but also to all the soluble oxalates, which will presently be proved to be likewise active poisons.—The tests are the hydrochlorate of lime, sulphate of copper, and nitrate of silver.

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* Lancet, 1830–31, i. 196.

Hydrochlorate of Lime causes a white precipitate, the oxalate of lime; which is dissolved on the addition of a drop or two of nitric acid,—and is not dissolved when similarly treated with hydrochloric acid, unless the acid is added in very large proportion.

The easy solubility of the oxalate of lime in nitric acid distinguishes the precipitate from the sulphate of lime, which the present test might throw down from solutions of the sulphates, and which is not soluble in a moderate quantity of nitric acid without the aid of heat. The insolubility of the oxalate of lime in hydrochloric acid on the other hand distinguishes the precipitate from the tartrate, citrate, carbonate and phosphate of lime, which the test might throw down from any solution containing a salt of these acids. The last four precipitates are re-dissolved by a drop or two of hydrochloric acid; but the oxalate is not taken up till a large quantity of that acid is added.

Sulphate of copper causes a faint bluish-white or greenish-white precipitate, which is not re-dissolved on the addition of a few drops of hydrochloric acid. The precipitate is the oxalate of copper. It is re-dissolved by a large proportion of hydrochloric acid.

This test does not precipitate the sulphates, hydrochlorates, nitrates, tartrates, citrates. But with the carbonates and phosphates it forms precipitates resembling the oxalate of copper. The oxalate, however, is distinguished from the carbonate and phosphate of copper by not being re-dissolved on the addition of a few drops of hydrochloric acid.

Nitrate of silver causes a dense, white precipitate, the oxalate of silver; which, when collected on a filter, dried, and heated, becomes brown on the edge, then fulminates faintly and is dispersed.

The object of the supplementary test of fulmination is to distinguish the oxalate of silver from the numberless other white precipitates which are thrown down by the nitrate of silver from solutions of other salts. The property of fulmination, which is very characteristic, requires, for security's sake, a word or two of explanation in consequence of the effect of heat on the tartrate and citrate of silver. The citrate when heated becomes altogether brown, froths up, and then deflagrates, discharging white fumes and leaving an abundant, ash-gray, coarsely fibrous, crumbly residue, which on the farther application of heat becomes pure white, being then pure silver. The tartrate, also becomes brown and froths up, but does not even deflagrate, white fumes are discharged, and there is left behind a botryoidal mass, which, like the residue from the citrate, becomes pure silver when heated to redness. Another distinction between the oxalate and tartrate is that the former continues permanent at the temperature of ebullition, while the latter becomes brown.—The preceding process or combination of tests will be amply sufficient for proving the presence of oxalic acid, free or combined, in any fluid which does not contain animal or vegetable principles.

2. Of the modifications in the analysis which are rendered necessary by the admixture of organic principles none are of any consequence except those required in the case of an examination of the contents of the alimentary canal or vomited matters.

Here a word or two must be premised on the changes which the poison may undergo in consequence of being mingled with other substances in the stomach or intestines. These may either be organic principles contained in the body, or substances introduced into the stomach as antidotes.

As to animal principles, Dr Coindet and I have proved, that oxalic acid has not any chemical action with any of the common animal principles except gelatin, which it rapidly dissolves;—and that this solution is of a peculiar kind, not being accompanied with any decomposition either of the acid or of the gelatin *. Consequently oxalic acid, so far as concerns the tissues of the stomach or its ordinary contents, is not altered in chemical form, and remains soluble in water.

In such a solution, however, a variety of soluble principles are contained, which would cause abundant precipitates with

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* Edin. Med. and Surg. Journal, xix. 168.

two of the tests of the process,—sulphate of copper and nitrate of silver; so that the oxalates of these metals could not possibly be exhibited in their characteristic forms. The process for a pure solution, therefore, is inapplicable to the mixtures under consideration.

But changes of still greater consequence are effected on the poison by exhibiting antidotes during life. It is now, I believe, generally known, since the researches of *Dr Thomson*, and those of *Dr Coindet* and myself, that the proper antidotes for oxalic acid are magnesia and chalk. Each of these forms an insoluble oxalate, so that if either had been given in sufficient quantity, no oxalic acid will remain in solution, and the proofs of the presence of the poison must be sought for in the solid contents of the stomach or solid matter vomited.

The following process for detecting the poison will apply to all the alterations which it may thus have undergone.

Process for compound mixtures. If chalk or magnesia has not been given as an antidote, the suspected mixture is to be macerated if necessary for a few hours in a little distilled water, then filtered, and the filtered fluid neutralized with carbonate of potass.—If on the other hand chalk or magnesia has been given, the mixture is to be left at rest for some time, and the supernatant fluid then removed. This fluid, if not acid, may be thrown away; but if acid, it may be treated as already directed for a suspected mixture, where chalk or magnesia has not obtained entrance. After the removal of the supernatant liquid, pick out as many solid fragments of animal or vegetable matter as possible; and add as much pure water to the insoluble residue as will give the mass a sufficiently thin consistence. Add now to the mixture about a twentieth of its weight of carbonate of potass, and boil gently for two hours, or till the organic matter is all dissolved. While dissolution thus takes place, a double interchange is effected between the elements of the carbonate of potass on the one hand, and those of the earthy oxalate on the other, so that an oxalate of potass will at length exist in solution. The fluid when cold is next to be filtered, then rendered very faintly acidulous with nitric acid, then filtered and rendered very faintly alkaline with carbonate of potass, and filtered a third time. At each of these steps some animal matter will be thrown down.

From this point onwards the process proceeds in the same way, whatever may have been the original form in which the acid existed in the mixture; for the oxalate of lime or magnesia in the second case is converted into oxalate of potass.

Add now the solution of acetate of lead to the fluid as long as any precipitate is formed. Collect the precipitate on a filter, wash it well, and dry it by compression between folds of bibulous paper. Remove this precipitate, which consists of oxalate of lead and organic matter in union with oxide of lead, and rub it up very carefully while damp with a little water in a mortar. Transmit sulphuretted hydrogen gas briskly for an hour, so that the whole white precipitate shall be thoroughly blackened; filter and boil. In this manner is formed a sulphuret of lead, which retains a great deal of animal matter; and the oxalic acid, being set free, is found in the solution tolerably pure. Filtration before boiling is an essential point in this step, to prevent animal matter being dissolved by the water from the sulphuret of lead. More animal matter may still be separated by evaporating the liquid to dryness at 212°, keeping it at that temperature for a few minutes, and redissolving and filtering.—The solution will now exhibit the properties of oxalic acid.

I have found that when this process was applied to a decoction of an ounce of beef in six ounces of water, with which one grain of anhydrous oxalic acid had been mixed, all the tests acted characteristically on the solution ultimately procured. I have farther found, that when two grains of oxalate of lime, which correspond with one grain of oxalic acid, were mixed with a similar decoction in which some fragments of beef were purposely left to complicate the process, a solution was eventually procured which gave with muriate of lime a white precipitate insoluble in a little muriatic acid, with sulphate of copper a greenish-white precipitate also insoluble in a little muriatic acid, and with nitrate of silver a white precipitate which fulminated and was almost all dispersed, but left a little charcoal, owing to its containing a small proportion of animal matter. In order to try the test of fulmination in such circumstances, it is essential to dry the precipitated oxalate of silver thoroughly before raising the temperature to the point at which fulmination usually occurs.

The process now recommended is both delicate and accurate. An objection has been advanced against it,—that acetate of lead will throw down chloride of lead as well as the oxalate of lead; that both will subsequently be decomposed by the sulphuretted-hydrogen; and that the hydrochloric acid thus brought into the solution with the oxalic acid will be precipitated by the nitrate of silver, and form a mixture of salts which will not fulminate characteristically*. This objection is not well-founded. Chloride of lead being soluble in thirty parts of temperate water, it will seldom be thrown down from such fluids as occur in medico-legal inquiries; and besides it is easily removed, as I have ascertained, by washing the precipitate with moderate care on the filter.—Caustic potass must not be used for decomposing the oxalate of lime or magnesia, because the pure alkali, as *Gay-Lussac* has shown, produces oxalic acid in acting on animal substances at a boiling temperature. Carbonate of potass has no such effect.

The discovery of oxalic acid in the form of oxalate of lime in the stomach or vomited matter is exposed to a singular fallacy, if a material quantity of rhubarb has been taken recently before death, or before the discharge of the vomited matter. For according to the researches of *M. Henry* of Paris, rhubarb root always contains some oxalate of lime, and some samples yield so much as 30 and even 33 per cent.†

SECTION II.—*On the Action of Oxalic Acid and the Symptoms it causes in Man.*

The action of oxalic acid on the animal economy is very peculiar.

When injected in a state of concentration into the stomach of a dog or cat, it causes exquisite pain, expressed by cries and struggling. In a few minutes this is succeeded by violent efforts to vomit; then by sudden dulness, languor, and great debility; and death soon takes place without a struggle. The period which elapses before death varies from two to twenty minutes, when the dose is considerable,—half an ounce, for example. After death the stomach is found to contain black extravasated blood, exactly like blood acted on by oxalic acid out of the body; the inner coat of the stomach is of a cherry-red colour, with streaks of black granular warty extravasation; and in some places the surface of the coat is very brittle and the subjacent stratum gelatinized, evidently by the chemical action of the poison *. If the stomach is examined immediately after death, little corrosion will be found, compared with what is seen if the inspection be delayed a day or two †.

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* Lancet, 1830-31, i. 197.

† Bulletins de Pharmacie, vi. 87.

Such are the effects of the concentrated acid. When considerably diluted, the phenomena are totally different. When dissolved in twenty parts of water, oxalic acid, like the mineral acids in the same circumstances, ceases to corrode; nay it hardly even irritates. But, unlike them, it continues a deadly poison; for it causes death by acting indirectly on the brain, spine, and heart. The symptoms then induced vary with the dose. When the quantity is large, the most prominent symptoms are those of palsy of the heart; and immediately after death that organ is found to have lost its contractility, and to contain arterial blood in its left cavities. When the dose is less the animal perishes after several fits of violent tetanus, which affects the respiratory muscles of the chest in particular, causing spasmodic fixing of the chest and consequent suffocation. When the dose is still less the spasms are slight or altogether wanting, and death occurs under symptoms of pure narcotism like those caused by opium: the animal appears to sleep away.

This poison acts with violence, and produces nearly the same effects, to whatever texture of the body it is applied. It causes death with great rapidity when injected into the sac of the peritonæum, or into that of the pleura; it acts with still greater quickness when injected into a vein; and it also acts when injected into the cellular tissue beneath the skin, but with much less celerity than through any other channel. Eight grains injected into the jugular vein of a dog occasioned almost immediate death: Thirty-three grains injected into the pleura killed another in twelve minutes. The same quantity did not prove fatal, though it caused violent effects, when retained in the stomach by a ligature on the gullet. One hundred and sixty grains injected under the skin of the thigh and belly did not prove fa-

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* Edin. Med. and Surg. Journal, xix. 166.

† Ibid. 169.

tal for about ten hours. The symptoms were nearly the same in every case [*].

It is probable from the facts now stated, that oxalic acid, when not sufficiently concentrated to occasion death by the local injury produced, acts on the nervous system through the medium of the blood. Nevertheless it is a remarkable circumstance that it cannot be detected in that fluid. Mention has already been made of an experiment performed by *Dr Coindet* and myself (p. 16,) where even after the immediate injection of eight grains of oxalic acid into the femoral vein, and the consequent death of the animal in thirty seconds, none of the poison could be detected in the blood of the iliac vein or vena cava. Similar results have been more lately obtained by *Dr Pommer*. In dogs killed by the gradual injection of from five to thirty grains into the femoral vein, he never could detect the poison in the blood of the right side of the heart or great veins, except in the instance of the largest doses, where a little could be detected near the opening in the vein. Dr Pommer's experiments likewise agree with those of Dr Coindet and myself as to the absence of any change in the physical qualities of the blood [†]. When to these circumstances it is added that very small quantities of oxalic acid may be detected in blood, into which it has been introduced immediately after removal from the body by venesection, it appears reasonable to conclude that the poison is quickly decomposed in the blood by means of some vital operations.

In man the most prominent symptoms hitherto observed have been those of excessive irritation, because it has been almost always swallowed in a large dose and much concentrated.

It is the most rapid and unerring of all the common poisons. The London Courier contains an inquest on the body of a young man who appears to have survived hardly ten minutes [‡]; an equally rapid case of a young lady, who poisoned herself with an ounce, is mentioned in the St James's Chronicle [§]; and few of those who have died survived above an hour. This rule, however, is by no means without exception.

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[*] Edin. Med. and Surg. Journal, xix. *passim*.

[†] Medizinisch-Chirurgische Zeitung, 1828, ii. 203, 219, 235, 254.

[‡] London Courier, Feb. 1, 1823.

[§] St James's Chronicle, August 17, 1826.

Mr Hebb has described a case which did not prove fatal for thirteen hours[*]; *Dr Arrowsmith* of Coventry has favoured me with the particulars of a very interesting case which lasted for the same period; and *Mr Frazer* has accurately described another in which, after the patient seemed to be doing tolerably well, an exhausting fever, with dyspepsia and singultus, carried him off in twenty-three days[†].

Among the fatal cases the smallest dose has been half an ounce; but there can be little doubt that less would be sufficient to cause death.

Very few persons have recovered where the quantity was considerable.

In every instance in which the dose was considerable, and the solution concentrated, the first symptoms have been immediate burning pain in the stomach, and generally also in the throat. But when the dose was small, more particularly if the solution was also rather diluted, the pain has sometimes been slight, or slow in commencing. Mr Hebb's patient, who took only half an ounce dissolved in ten parts of water, and diluted it immediately after with copious draughts of water, had not any pain in the belly for six hours.

In general, violent vomiting follows the accession of pain, either immediately, or in a few minutes; and it commonly continues till near death. Some, however, have not vomited at all, even when the acid was strong and in a large dose; and this is still more apt to happen when the poison has been taken much diluted. The man last mentioned did not vomit at all for seven hours, except when emetics were administered. The vomited matter, as in this man's case, and in that of Mr Frazer's patient, is sometimes bloody. Instant discharge of the poison by vomiting does not always save the patient's life: A woman who swallowed two ounces died in twenty minutes, although she vomited almost immediately after taking the poison[‡].

The tongue and mouth occasionally become inflamed if the case lasts long enough. In an instance of recovery, which happened not long ago in St Thomas's hospital, London, the tongue was red, swollen, tense, and tender, the day after the acid was swallowed *.

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[*] London Medical Repository, xxii. 476.

[†] Edin. Med. and Surg. Journal, xiv. 606.

[‡] Ibid. xix. 187.

Death commonly takes place so soon, that the bowels are seldom much affected. But when life is prolonged a few hours, they are evidently much irritated. Dr Arrowsmith's patient, who lived thirteen hours, had severe pain in the bowels and frequent inclination to go to stool, and Mr Hebb's patient, who also lived thirteen hours, had a constant, involuntary discharge of fluid fæces, occasionally mixed with blood. Bloody diarrhœa is very common in dogs.

The signs of depressed circulation are always very striking. In general the pulse fails altogether, it is always very feeble, and the skin is cold and clammy. Contrary to the general fact, however, I once remarked in a dog the pulsation of the heart so strong, as to be audible at a distance of several yards.

In some cases nervous symptoms have occurred, but in none so distinctly as in animals that have taken the diluted acid. It should be remarked, however, that few of the published cases contain good histories of the symptoms; since they commonly come to an end before being seen by the physician. The best instance yet related of the developement of nervous symptoms in man is a case described by *Dr Scott* of Cupar, of a girl who swallowed by mistake a solution kept for cleaning brass, and containing about two drachms. She did not vomit till emetics were given, but complained much of pain, which was succeeded by great lassitude and weakness of the limbs, and next morning by numbness and weakness there as well as in the back. This affection was at first so severe that she could hardly walk up stairs; but in a few days she recovered entirely †. There is also evidence to the same effect both in Mr Hebb's patient and in Dr Arrowsmith's case. The first thing the former complained of was acute pain in the back, gradually extending down the thighs, occasioning ere long great torture, and continuing almost till the moment of his death. Dr Arrowsmith's patient had the same symptoms, complained more of the pain shooting down from the loins to the limbs than of the pain in the belly, and was constantly seeking relief in a fresh change of posture. Mr Frazer's patient had from an early period a peculiar general numbness, approaching to palsy. These and other signs of nervous injury are to be looked for chiefly when the case is lingering, and the symptoms of irritation slight and late in appearing. Convulsions appear to have occurred in some instances either at the time of death or a short period before it.

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* London Medical Gazette, i. 737.

† Edin. Med. and Surg. Journal, xxiv. 67.

In Dr Arrowsmith's case two symptoms occurred, which I have not seen mentioned in any other history. The first was an eruption or mottled appearance of the skin in circular patches, not unlike the roundish red marks on the arms of stout healthy children, but of a deeper tint of redness. The second was the poisoning and death of leeches applied to the stomach. "They were healthy," says Dr Arrowsmith in the notes with which he obligingly furnished me, "small, and fastened immediately. On looking at them in a few minutes I remarked that they did not seem to fill, and on touching one it felt hard and immediately fell off, motionless and dead. The others were all in the same state. They had all bitten and the marks were conspicuous; but they had drawn scarcely any blood. They were applied about six hours after the acid was taken." This curious fact illustrates the observations formerly quoted from Vernière's experiments, [p. 69]. It will be observed that the leeches were applied several hours after the poison was swallowed, and in a case in which the acid was largely diluted in the stomach;—so that it might have entered the blood and been diffused throughout the body before the observation was made.

SECTION III.—*Of the Morbid Appearances caused by Oxalic Acid.*

The information hitherto collected on this subject is not very complete; for most authors of cases have been very loose and vague in the terms employed in their narratives.

The external appearance of the body is commonly natural. In one instance the cellular tissue was distended with gases ten hours after death[*]. Violent marks of irritation have been commonly found in the stomach; and sometimes that organ has been even perforated[†]. It is probable that the extensive destruction of the coats noticed by some authors has taken place in part after death from the action of the acid on the dead tissues. The best account I have yet seen of the morbid appearances is that given by Mr Hebb. The mucous coat of the throat and gullet looked as if it had been scalded, and that of the gullet could be easily scratched off. The stomach contained a pint of thick fluid. This is commonly dark, like coffee-grounds, as it contains a good deal of blood. The inner coat of the stomach was pulpy, in many points black, in others red. The inner membrane of the intestines was similarly but less violently affected. The outer coat of both stomach and intestines was inflamed. The lining membrane of the windpipe was also very red. In Mr Frazer's patient the whole villous coat of the stomach was either softened or removed, as well as the inner membrane of the gullet, so that the muscular coat was exposed; and this coat presented a dark gangrenous-like appearance, being much thickened and highly injected.

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[*] London Med. Repository, xi. 20.

[†] Ibid. vi. 474.

Although these signs of violent irritation are commonly present, it must at the same time be observed, that some cases have occurred where the stomach and intestines were quite healthy. In a girl who died about thirty minutes after swallowing an ounce of the acid, no morbid appearance whatsoever was to be seen in any part of the alimentary canal*.

The state of the other organs of the body has not been taken notice of in published cases. In several instances the blood in the veins of the stomach is described as having been black and as it were charred; which change is probably occasioned by the chemical action of the acid after death.

SECTION IV.—*Of the Treatment of Poisoning with Oxalic Acid.*

The chief part of the Treatment of this kind of poisoning is obvious. On account of its dreadful rapidity, remedies cannot be of material use unless they are resorted to immediately after the acid has been swallowed. Emetics may be given, if vomiting is not already free; but time should never be lost in administering them if an antidote is at hand. In particular it is necessary to avoid giving warm water with a view to accelerate vomiting, unless it is given very largely; for moderate dilution will promote the entrance of the poison into the blood, if it has not the effect of immediately expelling it.

The principal object of the practitioner should be to administer as speedily as possible large doses of magnesia or chalk suspended in water. Chalk has been given with great advantage in several cases [*], and magnesia has also been of service [†]. As no time should be lost, the plaster of the apartment may be resorted to, when chalk or magnesia is not at hand. These substances not only neutralize the acid so as to take away its corrosive power, but likewise render it insoluble, so as to prevent it from entering the blood. There appears no particular reason for using the stomach-pump in this variety of poisoning, when antidotes are at hand. But fashion seems to have authorized the employment of this instrument for every kind of poison [‡]. Alkalis which were once used as antidotes are inadmissible, because, as may be inferred from the general statements formerly made on the effect of chemical changes on poisons, [p. 22 and 32,] the alkalis, as they form only soluble salts, will not deprive oxalic acid of its remote or indirect action.

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* London Med. Repository, iii. 380.

Oxalic acid is one of the best examples of a poison that acts through all its soluble chemical combinations. *Dr Coindet* and I found that the oxalates of potass and ammonia are very little inferior in energy to the acid itself. They do not corrode; nay they hardly irritate; but they produce tetanus and coma, like the diluted acid. Half a drachm of oxalic acid neutralized with potass will kill a rabbit in seventeen minutes; ninety grains of the neutral oxalate of ammonia, which contain thirty-six of oxalic acid, will kill a strong cat in nine minutes [§]. The superoxalate of potass, or essential salt of lemons, as it is absurdly called in common speech, was unfortunately not tried by us. Being sparingly soluble and not very acid, it will probably be less active than the salts just mentioned, but nevertheless a poison in moderate doses.

Oxalic acid is one of the poisons alluded to under the head of General Poisoning,—of whose operation distinct evidence may sometines (though certainly not always) be found in the symptoms. If a person, immediately after swallowing a solution of a crystalline salt, which tasted purely and strongly acid, is attacked with burning in the throat, then with burning in the stomach, vomiting particularly of bloody matter, imperceptible pulse, and excessive languor, and dies in half an hour, or still more in twenty, fifteen, or ten minutes, I do not know any fallacy which can interfere with the conclusion, that oxalic acid was the cause of death. No parallel disease begins so abruptly and terminates so soon; and no other crystalline poison has the same effects.

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[*] London Medical Repository, xii. 18. London Medical Gazette, i. 737. Edinburgh Medical and Surgical Journal, xxiv. 67.

[†] Edin. Med. and Surg. Journal, xiv. 607.

[‡] London Medical Gazette, i. 737.

[§] Edin. Med. and Surg. Journal, xix. 190.

A few words may be here added on the effects of the other common vegetable acids, the citric and tartaric.

The *Tartaric* and *Citric* acids may be taken in considerable quantities without injury. *Dr Coindet* and I gave a drachm of each in solution to cats, without observing that the animals suffered any inconvenience*. *Dr Sibbald*, a surgeon of this place, has informed me of an instance in which a patient of his took in twenty-four hours six drachms of tartaric acid, having by mistake omitted the carbonate of potass sent along with the acid to make effervescing draughts; and yet he did not suffer any more inconvenience than the cats on which Dr Coindet and I experimented.

Pommer, however, found that tartaric acid is scarcely less active than oxalic when injected into the blood. When fifteen grains dissolved in half an ounce of water were injected into the femoral vein of a dog in four doses, difficult breathing and discharge of fæces and urine were produced after each operation, and death speedily ensued without any other particular symptom. As in the instance of oxalic acid, the blood in the great veins was not apparently changed in any of its physical qualities. The heart continued contractile long after death, while in the case of oxalic acid its contractility was suddenly extinguished†.

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* Edin. Med. and Surg. Journal, xix. 185.

† Medizinisch-Chirurgische Zeitung, 1828, ii. 255.

CHAPTER VII.

OF THE ALKALIS AND ALKALINE SALTS.

The Second Order of the Class of Irritants comprehends the alkalis, some of the alkaline salts, and lime. The species which it includes are little allied to one another except in chemical composition; and in particular they are little allied in physiological properties. It appears impossible, however, to make a better arrangement than that proposed by Orfila, which will therefore be here followed.

Most of the poisons of the second Order are powerful local irritants. Some of them likewise act indirectly on distant organs; and a few are more distinguished by their remote than by their local effects. This order may be conveniently divided into two groupes,—the one embracing the two fixed alkalis with their carbonates, nitrates, and chlorides, and also lime,—the other ammonia, with its salts, and likewise the alkaline sulphurets.

The action of the first groupe is purely irritant and strictly local. When concentrated, the fixed alkalis and their carbonates produce chemical decomposition, softening the animal tissues, and reducing them eventually to a pulpy mass; which change depends on their possessing the power, as chemical agents, of dissolving almost all the soft solids of the body. When much diluted, they produce inflammation, without corroding the textures; and it does not appear that they are even then absorbed in such quantity as to prove injurious to any remote organ. The action of the alkaline nitrates and of lime is that of irritants only; at least their chemical action is obscure and feeble.

Of the Fixed Alkalis and their Carbonates.

Section I.—*Of their Tests.*

Potass in its caustic state, as usually met with in the shops, forms little gray-coloured cylinders or cakes, which have a radiated, crystalline fracture, a soapy feel, and an excessively acrid caustic taste. It deliquesces rapidly in moist air, and then attracts carbonic acid from the atmosphere. It is easily fused by heat, and is exceedingly soluble in water. The solution has a strong alkaline reaction on the vegetable colours, restoring reddened litmus to blue, turning syrup of violets or infusion of red cabbage to green, and rendering infusion of turmeric brown. It is distinguished from the alkaline earths when in solution by not precipitating with carbonic or sulphuric acid, and from soda by the tests to be presently mentioned for its carbonate.

Carbonate of Potass [Subcarbonate, Salt of Tartar,] is usually sold, when pure, in small white grains, formed by melting the salt and stirring it rapidly as it cools. In its impure state it is called in this country Potashes, and when somewhat purified, Pearl Ash. It has then a mixed grayish, yellowish, or bluish colour, and is sold in crumbly lumps of various sizes. In every state it is deliquescent and very caustic. It cannot be crystallized. It gives out carbonic acid gas with the addition of any stronger acid, such as sulphuric, muriatic, or acetic acid. Its solution precipitates yellow with the chloride of platinum, gives a crystalline precipitate with perchloric acid, when the salt forms not less than a fortieth or fiftieth part, and yields with the soluble salts of baryta a white precipitate soluble in nitric acid.

Soda resembles potass closely in chemical as well as physiological properties; and the *Carbonate* bears the same resemblance to the carbonate of potass. The chief differences are the following. The carbonate of soda is easily crystallized, and effloresces on exposure to the air. All its salts remain unaffected by the chloride of platinum, because their base cannot form like potass an insoluble triple salt with the reagent. The acetate of soda is permanent in the air, while the acetate of potass is one of the most deliquescent salts known. In trying this last test, which is very characteristic, care must be taken to avoid an excess of acid in the acetate of soda by expelling it at a temperature of 212°, otherwise the salt is as deliquescent as the acetate of potass.—Another difference which I have not seen mentioned is, that the chloride of sodium, being nearly as soluble in temperate as in boiling water, crystallizes with difficulty and but sparingly by cooling a concentrated boiling solution; while the chloride of potassium is much more soluble in hot than in cold water, and crystallizes easily and abundantly when a concentrated boiling solution is cooled down.—An excellent and convenient test, which will probably supersede all the rest, has also been lately proposed by *M. Sérullas.* This is the perchloric acid already alluded to. The perchlorate of soda is extremely soluble and even deliquescent, while the perchlorate of potass requires sixty-five parts of water at 60° F. for its solution. Hence when the perchloric acid is dropped into a moderately concentrated solution of the salts of potass, a crystalline powder is precipitated; but the salts of soda are not affected. The perchloric acid may be prepared sufficiently pure for the purpose in the following manner. The perchlorate of potass is first formed by fusing the chlorate (oxymuriate) of potass and maintaining it for some hours at a temperature just sufficient to cause slow disengagement of gaseous bubbles from it,—then dissolving the mass in eight parts of boiling water,—and allowing the solution to cool. The perchlorate, being much less soluble than the chlorate and chloride, crystallizes free from these salts, or is thoroughly freed from them by a second crystallization from a boiling solution. From the perchlorate of potass, the perchloric acid may be procured sufficiently pure by distilling in a small retort six parts of the salt with three of sulphuric acid and one of water.

SECTION II.—*Of the Action of the fixed Alkalis, and the symptoms they cause in Man.*

The action of the two fixed alkalis and their carbonates on the animal system is so nearly the same, that the facts which have been ascertained in respect to one of them will apply to all the rest. The operation of potass and its carbonate has been carefully investigated by *Professor Orfila**, and by *M. Bretonneau* of Tours †.

When Caustic Potass is injected in minute portions into the veins, it instantly coagulates the blood. Five grains, according to Orfila, will in this way kill a dog in two minutes. When introduced into the stomach it acts powerfully as an irritant, and generally corrodes the coats of that organ. Thirty-two grains given by Orfila to a dog caused pain in the gullet, violent vomiting, much anguish, restlessness, and death on the third day. On dissection he found the inner coat of the gullet and stomach black and red; and near the pylorus there was a perforation three-quarters of an inch wide, and surrounded by a hard, elevated margin. The observations of Bretonneau are in some respects different. When potass was swallowed by dogs in the dose of 40 grains, he found that the animals, after suffering for some time from violent vomiting, always died sooner or later of wasting and exhaustion; and that the action of the poison was confined chiefly to the gullet, which was extensively destroyed and ulcerated on its inner surface. But when the gullet was defended by the potass being passed at once into the stomach in a caustic-holder, larger doses, even several times repeated, did not prove fatal. The usual violent symptoms of irritation prevailed for two or three days; but on these subsiding, the animals rapidly recovered their appetite and playfulness, appearing in fact to be restored to perfect health. Yet there could be no doubt that the stomach all the while was severely injured; for in some of the animals, which were strangled for the sake of examination several weeks after they took the poison, the villous coat was found extensively removed, and even the muscular and peritonæal coats were here and there destroyed and cicatrized. Bretonneau farther adds, that ten or fifteen grains introduced into the rectum caused death sooner than three times as much given by the mouth.

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* *Toxicol. Gen.* i. 164. 3me Edition.

† *Ibid.* 166, and also *Archives Gén. de Méd.* xiii. 373.

The Carbonate of potass possesses properties similar in kind, but inferior in degree. Two drachms given by Orfila to a dog killed it in twenty-five minutes, violent vomiting and great agony having preceded death. The stomach was universally of a deep red colour on its inner surface.

I have not hitherto met with any account of a case of poisoning in the human subject with the caustic alkalis; but the effects of their carbonates have been several times witnessed, and appear to resemble closely those of the concentrated mineral acids.

The symptoms are in the first instance an acrid burning taste, and rapid destruction of the lining membrane of the mouth; then burning and often constriction in the throat and gullet, with difficult and painful deglutition; violent vomiting, often sanguinolent, and tinging vegetable blues green; next acute pain in the stomach and tenderness of the whole belly; subsequently cold sweats, excessive weakness, hiccup, tremors and twitches of the extremities; and ere long violent colic pains, with purging of bloody stools and dark membranous flakes. So far the symptoms are nearly the same in all cases; but in their subsequent course several varieties may be noticed.

In the worst form of poisoning death ensues at an early period, for example within twenty-four hours, nay even before time enough has elapsed for diarrhœa to begin. A case of this kind, which has been very well described by *Mr Dewar* of Dunfermline, and which arose from the patient, a boy, having accidentally swallowed about three ounces of a strong solution of carbonate of potass, proved fatal in twelve hours only [*]. Here death was owing to the general system or some vital organ being affected through sympathy by the injury sustained by the alimentary canal.

In the mildest form, as in a case related by *Plenck* [†] of a man who swallowed an ounce of the carbonate of potass, the symptoms represent pretty nearly an attack of acute gastritis when followed by recovery,—the effects on man being then analogous to those observed by Bretonneau in animals, when the poison was introduced into the stomach without touching the gullet.

But a much more common form than either of the preceding is one, similar to the chronic form of poisoning with the mineral acids, in which constant vomiting of food and drink, incessant discharge of fluid, sanguinolent stools, difficulty of swallowing, burning pain from the mouth to the anus, and rapid emaciation, continue for weeks or even months before the patient's strength is exhausted; and where death is evidently owing to starvation, the alimentary canal being no longer capable of assimilating food. Two characteristic examples of this singular affection have been recorded in the Medical Repository [‡], and a third, of which the event has not been mentioned, but which would in all likelihood end fatally, has been communicated by *M. Jules Cloquet* to Orfila [§]. Of the two first cases, which were caused by half an ounce of carbonate of potass having been taken in solution by mistake for a laxative salt, one proved fatal in little more than a month, the other three weeks afterwards. In Cloquet's case, at the end of the sixth week the membrane of the mouth was regenerated; but the gullet continued to discharge pus, and the stools were purulent and bloody.

Another form, perhaps equally common with that just described, and not less certainly fatal, commences like the rest with violent symptoms of irritation in the mouth, gullet, and stomach; but the bowels are not affected, and by and bye it becomes apparent that the stomach is also little injured; dysphagia or even complete inability to swallow, burning pain and constriction in the gullet, hawking and coughing of tough, leathery flakes, are then the leading symptoms; at length the case becomes one of stricture of the œsophagus, with or without ulceration; the bougie gives only temporary relief, and the patient eventually expires either of mere starvation, or of that combined with an exhausting fever. *Mr Dewar* has related a very striking example of this form of poisoning with the alkalis*. His patient, after the first violent symptoms had exhausted themselves, which took place in sixteen or eighteen hours, suffered little for four or five days till the sloughs began to separate from the lining membrane of the mouth, throat, and gullet. The affection of the gullet then became gradually predominant, and terminated in stricture, of which she appears to have been several times so much relieved as to have been thought in a fair way of recovery. After repeatedly disappointing Mr Dewar's hopes of a successful issue by her intemperance in the use of spirituous liquors, she died of starvation about four months after swallowing the poison. *Sir Charles Bell* has noticed three parallel cases, and has given delineations of the appearances in the gullet of two of them †. One of his patients did not die till twenty years after swallowing the poison, which in this instance was soap-lees; yet he does not hesitate to ascribe the stricture to that cause, and says death arose purely from starvation.

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[*] Edin. Med. and Surg. Journal, xxx. 310.

[†] Toxicologia, p. 225.

[‡] London Med. Repository, vii. 118.

[§] Orfila, Toxic. Générale, i. 167.

SECTION III.—*Of the Morbid Appearances caused by the fixed Alkalis.*

The Morbid Appearances caused by potass, soda, and their carbonates differ with the nature of the case.

In the boy who died in twelve hours Mr Dewar found the inner membrane of the throat and gullet almost entirely disorganized and reduced to a pulp, with blood extravasated between it and the muscular coat. The inner coat of the stomach was red, in two round patches destroyed, and the patches covered with a clot of blood;—its outer coat, as well as all the other abdominal viscera, was sound.

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* Edin. Med. and Surg. Journ. xxx. 310.

† Surgical Observations, Part i. 82.

In the two chronic cases mentioned in the Medical Repository the mischief was much more general, the whole peritonæum being condensed, the omentum dark and turgid, the intestines glued together by lymph, the external coats of the stomach thick, the villous coat almost all destroyed, what remained of it red and near the pylorus ulcerated, the pyloric orifice of the stomach plugged up with lymph so as barely to admit a small probe.

In Mr Dewar's patient who died of stricture of the gullet, the intestines were sound, the inner surface of the stomach red especially towards the cardia, the inner and muscular coats of the gullet thickened and firmly incorporated together by effused lymph, the inner coat here and there wanting, the passage of the gullet every where contracted, and to such a degree about two inches above the cardia as hardly to pass a common probe. In Mr Bell's cases the appearances were similar.

Orfila says he is led to conclude from a great number of facts that of all corrosive poisons potass is the one which most frequently perforates the stomach [*]. This appearance, however, has not been mentioned in any of the cases of poisoning in the human subject.

SECTION IV.—*Of the Treatment of Poisoning with the fixed Alkalis.*

In the treatment of poisoning with the alkalis the first object is evidently to neutralize the poison. This may be done either with a weak acid, or with oil. Of the acids the acetic in the form of vinegar is most generally recommended, as it is not itself injurious. *M. Chereau*, however, has stated that for the mineral alkalis and their carbonates fixed oil is a preferable antidote; and he has given the heads of two cases of poisoning with large doses of carbonate of potass, in which the free employment of almond oil prevented the usual fatal consequences. It appears to act partly by rendering the vomiting free and easy, partly by converting the alkali into a soap. It must be given in large quantity, several pounds being commonly required [†]. For the subsequent treatment the reader may consult the paper of Mr Dewar, which contains many useful hints on the management of the most complex description of cases.

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[*] Toxic. Générale, i. 169.

[†] Journal de Pharmacie, ix. 355, or Med. Repos. xx. 441.

CHAPTER VIII.

OF POISONING WITH NITRATE OF POTASS.

THE *Nitrate of Potass*, [nitre, salpetre, sal-prunelle,] is a dangerous poison. It has been often mistaken for the saline laxatives, especially for the sulphate of soda, and has thus been the source of fatal accidents.

SECTION I.—*Of the Chemical Tests for Nitrate of Potass.*

It exists in commerce and the arts in two forms, fused and crystallized. The fused nitre [Sal-prunelle] is sold in little button-shaped masses, bullets of the size of musket-balls, or larger circular cakes, of a beautiful snow-white tint. The crystallized salt [Salpetre] is sold in whitish, sulcated crystals, which are often regular and large. They are six-sided prisms, more or less flattened, and terminated by two converging planes. In both forms nitre has a peculiar, cool, but sharp taste.

Its chemical properties are characteristic. In the solid form, it animates the combustion of burning fuel, and yields nitrous fumes when heated with strong sulphuric acid. In solution it is precipitated yellow by the chloride of platinum, and yields, when not greatly diluted, a crystalline precipitate with perchloric acid. The salt of commerce contains some muriate of soda; and hence the odour disengaged by sulphuric acid is often mixed with that of chlorine or hydrochloric acid gas. If it is mixed with any vegetable or animal infusion by which it is coloured, it will sometimes be practicable to procure the crystals in a state of sufficient purity by filtration and evaporation. But if not, then the same process must be resorted to with that formerly recommended for nitric acid (p. 152), the first step of neutralization with potass being of course dispensed with.

SECTION II.—*Of the Action of Nitrate of Potass and its Symptoms in Man.*

This substance forms an exception to the general law formerly laid down with regard to the effect of chemical neutralization on the pure local irritants. Both its acid and its alkali are simple irritants; yet the compound salt, though certainly much inferior in power, is still very energetic: Nay, the experiments of Orfila and the particulars of some recently published cases tend even to prove that the action of its alkali and acid is materially altered in kind by their combination with one another; for, besides inflaming the part to which it is applied, nitre has at times produced symptoms of a secondary disorder of the brain and nerves.

The experiments of Orfila upon dogs show that on these animals it has a twofold action, the one irritating, the other narcotic. He found that an ounce and a-half killed a dog in ninety minutes when the gullet was tied, and a drachm another in twenty-nine hours: that death was preceded by giddiness, slight convulsions, dilated pupil, insensibility and palsy; that after death the stomach was externally livid, internally reddish-black, and the heart filled in its left cavities with florid blood; that when the gullet was not tied the animals recovered after several attacks of vomiting, and general indisposition for twenty-four hours; and that when the salt was applied externally to a wound it excited violent inflammation, passing on to gangrene, but without any symptoms which indicated a remote or indirect operation *.

As to its effects on man, it must first be observed, that considerable doses are necessary to cause serious mischief. In the quantity of one, two, or three scruples, it is often given medicinally several times a-day without injury to the patient; and *Dr Alexander* found by experiments on himself, that an ounce and a-half, if largely diluted, might thus be safely administered in the course of twenty-four hours †. Sometimes, too, even large single doses have been swallowed with impunity. A gentleman of my acquaintance once took nearly an ounce by mistake for Glauber's salt, and retained it above a quarter of an hour; nevertheless, except several attacks of vomiting, no unpleasant symptom was induced. *M. Tourtelle* has even related an instance where two ounces were retained altogether and caused only moderate griping, with considerable purging and flow of urine ‡. Resting on such facts as these Tourtelle, with some physicians in more recent times[*], has maintained that nitre is not a worse poison than other saline laxatives; and some practitioners of the present day have consequently ventured to administer it for the cure of diseases, in the quantity of half an ounce in one dose[†]. It is not easy to say, why these large doses are at times borne by the stomach without injury,—whether the cause is idiosyncrasy, or a constitutional insensibility engendered by disease, or some difference in the mode of administering the salt. But at all events, the facts which follow will leave no doubt that in general it is a dangerous and rapid poison in the dose of an ounce.

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* Toxic. Gén. i. 193.

† Experimental Essays, p. 113.

‡ Journal de Médecine, lxxiii. 22.

Dr Alexander found that, in the quantity of a drachm or a drachm and a-half, recently dissolved in four ounces of water, and repeated every ninety minutes, the third or fourth dose caused chilliness and stinging pains in the stomach and over the whole body; and these sensations became so severe with the fourth dose, that he considered it unsafe to attempt a fifth[‡].

Two cases which were actually fatal have been described in the Journal de Médecine for 1787, the one caused by one ounce, the other by an ounce and a-half. In the latter the symptoms were those of the most violent cholera, and the patient died in two days and a-half[§]; in the former death took place in three hours only, and in addition to the symptoms remarked in the other there were convulsions and twisting of the mouth[‖]. In both the pulse failed at the wrist, and a great tendency to fainting prevailed for some time before death.

Similar effects have been remarked in several cases which have been followed by recovery.—A woman in the second month of pregnancy, immediately after taking a handful of nitre in solution, was attacked with pain in the stomach, swelling of the whole body and general pains; she then miscarried, and afterwards had the usual symptoms of gastritis and dysentery, united with great giddiness, ringing in the ears, general tremors and excessive chilliness. She seems to have made a narrow escape, as for three days the discharges by stool were profuse, and composed chiefly of blood and membranous flakes[*].—*Dr Falconer* has related another instance, where also the patient's life seems to have been in great danger. The quantity taken was two ounces, and it was swallowed in half a pint of warm water by mistake instead of a laxative salt. Violent pain in the belly was immediately produced, in half an hour frequent vomiting, and in three hours a discharge of about a quart of blood from the stomach. After the administration of gruel and butter the symptoms began to subside; but they receded slowly; and even six months afterwards the man, though otherwise in good health, had frequent pain in the stomach and flatulence[†].—In the case of a female in the second month of pregnancy, described by *Dr Butter*, miscarriage did not take place, although the symptoms were very violent and lasting. The quantity taken was two ounces. The symptoms were first bloody vomiting, afterwards dysentery, which continued seven days; and on the tenth day a nervous affection supervened exactly like chorea, and of two months' duration[‡]. The effects of the poison in the latter period of this woman's illness tend to establish the existence of a secondary operation on the nervous system. But this kind of action is still more strongly pointed out by the particulars of a case related by *Dr Geiseler*, in which the only disorder produced appeared to depend on derangement of the cerebral functions. A woman, after swallowing an ounce of nitre instead of Glauber's salt, lost the use of speech and the power of voluntary motion, then became insensible, and was attacked with tetanic spasms. This state lasted till next day, when some amelioration was procured by copious sweating. It was not, however, till eight days after, that she recovered her speech, or the entire use of her mental faculties; and the palsy of the limbs continued two months[§]. Her case resembles the account given by Orfila of the effects of nitre on animals.

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[*] Tartra sur l'empoisonnement par l'acide nitrique, 136.

[†] London Med. Repository, xxiii. 523.

[‡] Experimental Essays, p. 114, 115.

[§] *Souville* in Journal de Médecine, lxxiii. 19.

[‖] *Laflize* in Journ. de Méd. lxxi. 401.

SECTION III.—*Of the Morbid Appearances caused by Nitrate of Potass.*

The Morbid Appearances observed in man are solely those of violent inflammation of the stomach and intestines. In Laflize's case, which proved fatal in three hours, the stomach was distended, and the contents deeply tinged with blood; its peritoneal coat of a dark red colour mottled with black spots; its villous coat very much inflamed and detached in several places. The liquid contents gave satisfactory evidence of nitre having been swallowed; for a portion evaporated to dryness deflagrated with burning charcoal. In Souville's patient, who lived sixty hours, the stomach was every where red, in many places checkered with black spots, and at the centre of one of these spots the stomach was perforated by a small aperture. The whole intestinal canal was also red.

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[*] *Alexander*, Experimental Essays, p. 109.

[†] Memoirs of London Med. Society, iii. 527.

[‡] Edin. Med. and Surg. Journ. xiv. 34.

[§] Journal der Praktischen Heilkunde, lvii. i. 124.

CHAPTER IX.

OF POISONING WITH THE ALKALINE AND EARTHY CHLORIDES.

There can be little doubt that the *Chlorides* of *Soda*, *Potass*, and *Lime* are active poisons; but their effects have not hitherto been carefully investigated by physiological experiments, with the exception of those of chloride of soda.

The two alkaline chlorides are usually seen in the form of colourless solutions. That of potass, the Eau de Javelle of the French, is little known in this country; but that of soda is familiar to all in the shape of Fincham's chloride of soda or bleaching liquid. The chloride of lime, which is best known of them all, is usually in the form of a dry powder, deliquescent, and acrid, commonly termed Bleaching powder. All these substances are easily known by their peculiar odour of chlorine, and the copious disengagement of that gas on the addition of sulphuric acid.

The action of chloride of soda on the animal body has been examined by *Segalas*, who infers that it is an irritant poison, which, however, at times occasions symptoms of an affection of the nervous system. He remarked that three ounces of the solution commonly sold in Paris under the name of Labarraque's disinfecting liquid cause immediately death by coagulating the blood in the heart, when injected into a vein in a dog. Two ounces introduced into the peritonæum excited palpitation, oppressed breathing, constant restlessness, and death in ten minutes; and three drachms did not prove fatal for some hours, tetanic spasms being produced in the first instance, and peritonæal inflammation being found after death. One ounce introduced into the stomach of a dog excited immediate vomiting, and no farther inconvenience; and two ounces retained by a ligature on the gullet brought on violent efforts to vomit, from which the animal was gradually recovering, when it was killed in twenty-four hours for the sake of observing the appearances. The stomach was found generally inflamed and interspersed with dark, gangrenous-like spots[*].

I am not acquainted with any case of poisoning with these substances in the human subject. But it is probable that symptoms of pure irritation and inflammation will occur, and that moderate doses may prove fatal.

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[*] Journal de Physiologie, iii. 243.

CHAPTER X.

OF POISONING WITH LIME.

Lime, the last poison of the present groupe, is a substance of little interest to the toxicologist, as its activity is not great.

Its physical and chemical properties need not be minutely described. It is soluble, though sparingly, in water; and the solution turns the vegetable blues green, restores the purple of reddened litmus, gives a white precipitate with a stream of carbonic acid gas, and with oxalic acid a very insoluble precipitate, which is not redissolved by an excess of the test.

Its action is purely irritant. *Orfila* has found that a drachm and a half of unslaked lime, given to a little dog, caused vomiting and slight suffering for a day only, but that three drachms killed the same animal in five days, vomiting, languor, and whining being the only symptoms, and redness of the throat, gullet, and stomach, the only morbid appearances[*].

Though a feeble poison, it has nevertheless proved fatal in the human subject. *Gmelin* takes notice of the case of a boy who swallowed some lime in an apple-pye, and died in nine days, affected with thirst, burning in the mouth, burning pain in the belly, and obstinate constipation[†]. A short account of a case of this kind of poisoning is also given by *Balthazar Timæus*. A young woman, afflicted with pica or depraved appetite, took to the eating of quicklime; and in consequence she was attacked with pain and gnawing in the belly, sore throat, dryness of the mouth, insatiable thirst, difficult breathing and cough; but she recovered[‡].—It is well known that quicklime also inflames the skin or even destroys its texture, apparently by withdrawing the water which forms a component part of all soft animal tissues. When thrown into the eyes it causes acute and obstinate ophthalmia, which may end in loss of sight. On this account it will belong, I presume, to the poisons included in the Scottish act against disfiguring or maiming with corrosives.

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[*] Toxicol. Gén. i. 174.

[†] Gmelin's Geschichte der Mineralischen Gifte, s. 252.

[‡] Timæi Casus Medicinales, lvii. c. 12.

CHAPTER XI.

OF POISONING WITH AMMONIA AND ITS SALTS.

The second groupe of the order of Alkaline poisons, including ammonia with its salts, and the sulphuret of potass, have a double action on the system, analogous to that possessed by many metallic poisons. They are powerful irritants; but they produce besides, through the medium of the blood, a disorder of some part of the nervous system; and their remote is sometimes more dangerous than their local action. The nervous affection produced by ammonia and the sulphuret of potass closely resembles tetanus, and therefore depends probably on irritation of the spinal column.

Of the Chemical tests for the Ammoniacal Salts. Ammonia is when pure a gaseous body; but as commonly seen, it exists in solution in water, which dissolves it in large quantity. The solution has the usual effects of alkalis on vegetable colours, with the difference, however,—that the changes of colour are not permanent under the action of heat. It precipitates yellow, as potass does, with the chloride of platinum. It may at once be distinguished from other fluids by its peculiar pungent odour, which is possessed by no other substance except its carbonate.

Various *Carbonates* are known in chemistry, but the only one known in commerce or met with in the shops is the sesqui-carbonate (Sub-carbonate,—Smelling Salt—Volatile Salt—Hartshorn.) It is solid, white, fibrous, and has the same odour as pure ammonia. Its solution differs little in physical properties from the pure liquid ammonia; but, unlike it, is precipitated by the salts of lime.

The *Hydrochlorate*—(muriate of ammonia—Sal ammoniac) is known by its solid, white, crystalline appearance; its ductility; its volatility; and by the effect of caustic potass and nitrate of silver, the former of which disengages an ammoniacal odour, while the latter causes in a solution of the salt a white precipitate, the chloride of silver.

Of the action of the Ammoniacal Salts, and their effects on man.

To determine the action of ammonia on the animal system, Professor Orfila injected sixty grains of the pure solution into the jugular vein of a dog. Immediately the whole legs were spasmodically extended; at times convulsions occurred; and in ten minutes it died. The chest being laid open instantly, coagulated florid blood was seen in the left ventricle, and black fluid blood in the right ventricle of the heart. No morbid appearance was discernible any where else except complete exhaustion of the muscular irritability. Half a drachm of a strong solution was introduced into the stomach of another dog and the gullet tied. The animal was at first much agitated; but in five minutes became still and soporose; after five hours it continued able to walk; in twenty hours it was found quite comatose; and death ensued in four hours more. The only morbid appearance was slight mottled redness of the villous coat of the stomach. A third dog, to which two drachms and a half of the common carbonate were given in fine powder, died in twelve minutes. First it vomited; next it became slightly convulsed; and the convulsions gradually increased in strength and frequency till the whole body was agitated by dreadful spasms; then the limbs became rigid, the body and head were bent backwards, and in this state it expired, apparently suffocated in a fit of tetanus *.

Several cases of poisoning with ammonia or its carbonate have occurred in the human subject. *Plenck* has noticed shortly a case which proved fatal in four minutes, and which was caused by a little bottleful of ammonia having been poured into the mouth of a man who had been bitten by a mad-dog†. The symptoms are not mentioned, but it is probable, from the rapidity of the poisoning, that a nervous affection must have been induced. More generally, however, the effects are simply irritant; and the seat of the irritation will vary with the mode in which the poison is given. If it is swallowed the stomach and intestines will suffer; if it is imprudently inhaled in too great quantity, inflammation of the lining membrane of the nostrils and air-passages will ensue. *Huxham* has related a very interesting example of the former affection, as it occurred in a young man, who had acquired a strange habit of chewing the solid carbonate of the shops. He was seized with great hemorrhage from the nose, gums, and intestines; his teeth dropped out; wasting and hectic fever ensued; and, although he was at length prevailed on to abandon his pernicious habit, he died of extreme exhaustion, after lingering several months *. A very striking instance of bronchial inflammation, arising from the imprudent and excessive use of ammonia as a stimulant to the nostrils, has been related by *M. Nysten*. A medical man, liable to epilepsy, was found in a fit by his servant, who ignorantly tried to rouse him by holding to his nostrils a handkerchief dipped in ammonia. In this way about two drachms appear to have been consumed. On recovering his senses, the patient complained of burning pain from the mouth downwards to the stomach, great difficulty in swallowing, difficult breathing, hard cough, and copious expectoration, profuse mucous discharge from the nostrils, and excoriation of the tongue. The bronchitis increased steadily, and carried him off in the course of the third day, without convulsions or any mental disorder having supervened †. A case precisely similar is related in the Edinburgh Medical and Surgical Journal. A lad, while convalescent from an attack of fever, was seized with epilepsy, for which his attendant applied ammonia under his nose "with such unwearied, but destructive benevolence, that suffocation had almost resulted. As it was, dyspnœa, with severe pain of the throat and breast, immediately succeeded; and death took place forty-eight hours afterwards ‡." A third instance has been recorded of analogous effects produced by the incautious use of ammonia as an antidote for prussic acid. The patient had all the symptoms of a violent bronchitis, accompanied with redness and scattered ulceration of the mouth and throat; but he recovered in thirteen days §.

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* Orfila, Toxic. Gén. i. 220.

† Plenck, Toxicologia, 226.

Nysten's case is the only one in the human subject in which the *Morbid Appearances* were ascertained. The nostrils were blocked up with an albuminous membrane. The whole mucous membrane of the larynx, trachea, bronchi, and even of some of the bronchial ramifications, was mottled with patches of lymph. The gullet and stomach showed red streaks here and there; and there was a black eschar on the tongue, and another on the lower lip.

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* Essay on Fevers, p. 308.

† Bulletins de la Soc. de Méd. 1815, No. viii. T. iv. 352.

‡ Edinburgh Medical and Surgical Journal, xiv. 642.

§ Revue Médicale, xvii. 265.

Of poisoning with Hydrochlorate of Ammonia.—The effects of the Hydrochlorate of Ammonia on animals have been examined by Professor Orfila and Dr Arnold; but I have not yet met with any instance of its operation as a poison on man. When given to dogs it irritates and inflames the parts it touches, and causes the ordinary symptoms of local irritation. But it also acts remotely. For, first, like arsenic, and other poisons of the Third Order of Irritants, it produces inflammation of the stomach, in whatever way it is applied to the body,—Orfila having found that organ affected when the salt was applied to the subcutaneous cellular tissue[*]; and, secondly, according to the experiments of Arnold, it causes, when swallowed, excessive muscular weakness, slow breathing, violent action of the heart, and tetanic spasms,—effects which cannot arise from mere injury of the stomach. Half a drachm will thus kill a rabbit in eight or ten minutes[†]; and two drachms a small dog in an hour[‡].

[*] Orfila, Toxicol. Gén. i. 229.

[†] De salis ammoniaci vi, &c. Heidelberg, 1826. Analyzed in Revue Méd. 1827, i. 284.

[‡] Orfila, i. 228.

CHAPTER XII.

OF POISONING WITH THE ALKALINE SULPHURETS.

The liver of sulphur, or sulphuret of potass of the pharmacopœias, the last poison of this order to be mentioned, is allied to the ammoniacal salts in action. It is a substance of no great consequence in a toxicological point of view in this country, as it is put to very little use; but several fatal accidents have been caused by it in France, where it is a good deal employed for manufacturing artificial sulphureous waters; and it is farther necessary that its properties be accurately ascertained, as it has been much and erroneously resorted to as an antidote for some metallic poisons.

Chemical Tests.—It has a grayish, greenish, or yellowish colour when solid; its dust smells of sulphuretted hydrogen, which is also copiously disengaged from it by the mineral acids; and it forms with water a yellow solution of the same odour.

Action and Symptoms.—*Orfila* found that a solution of six drachms and a half, secured in the stomach of a dog by a ligature on the gullet, caused death by tetanus in seven minutes, without leaving any particular morbid appearance in the body; that inferior doses caused death in the same manner, but at a later period, and with the intervention of symptoms of irritation in the alimentary canal, which also was seen red, black, or even ulcerated after death; that a solution of twenty-two grains injected into the jugular vein killed a dog in two minutes, convulsions having preceded death, and the heart being found paralyzed immediately after it; and that a drachm and a half thrust in small fragments under the skin occasioned death by coma in thirteen hours, and extensive inflammation of the cellular tissue *. There can be no doubt, therefore, that liver of sulphur is a true narcotico-acrid poison.

The same author has collected three cases of poisoning in the human subject with this substance †; and a fourth has been related by *M. Cayol*[*]. Of these cases two have proved fatal, both in less than fifteen minutes, and the symptoms preceding death were acrid taste, slight vomiting, mortal faintness, and convulsions, with an important chemical sign, the tainting of the air of the chamber with the odour of sulphuretted-hydrogen. The dose in one case was about three drachms. The two other patients, who recovered, were for some days dangerously ill. The symptoms in them were burning pain and constriction in the throat, gullet, and stomach; frequent vomiting, at first sulphureous, afterwards sanguinolent; purging, at first sulphureous; sulphureous exhalations from the mouth; pulse at first quick and strong, afterwards feeble, fluttering, and almost imperceptible, accompanied in one case with sopor; finally severe inflammation of the gullet, stomach, and intestines, which abated in three days. One of these patients took four drachms of sulphuret of soda, the other two ounces of sulphuret of potass; but it is probable, as Orfila conjectures, that the latter dose must have been partly decomposed by long keeping.

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* Toxic. Gen. i. 177.

† Ibid. 181. Two from an Essay by *M. Chantourelle*, read before the Acad.

Morbid Appearances.—The morbid appearances in the two fatal cases were great lividity of the face and extremities, and exhaustion of the muscular contractility immediately after death; the stomach was red internally, and lined with a crust of sulphur; the duodenum also red; the lungs soft, gorged with black fluid blood, and not crepitating.

Treatment.—The most appropriate treatment, according to the results of M. Chantourelle's case, seems to consist in the instant administration of any diluent which is at hand, the subsequent administration of frequent doses of the chloride of soda, and then the antiphlogistic mode of subduing inflammation. The chloride of soda or lime may be called the antidote against this poison, as it decomposes the sulphuretted-hydrogen which is evolved, and the rapid disengagement of which is the probable cause of death in the quickly fatal cases. The symptoms at least are very nearly those of poisoning with sulphuretted-hydrogen when introduced into the system in a more direct manner[†].

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de Médecine; and one from *M. Lafranque* in Ann. de la Méd. Physiolog. Fevrier 1825.

[*] Journ. Universel, xviii. 265.

[†] See *Poisonous Gases.*

CHAPTER XIII.

OF POISONING WITH ARSENIC.

The Third Order of the Irritant Class of Poisons includes the compounds of the Metals. These are of great importance to the medical jurist. They are frequently used for criminal purposes; they give rise to the greatest variety of symptoms; and the medical evidence on trials respecting them, while much skill is required on the part of the witness to collect it, is also the most conclusive.

It must not be inferred from their being arranged in the class of Irritants that their action is merely local. In fact this is the case with a very few of them only, which produce chemical corrosion. The greater number likewise act indirectly on organs at a distance from the part to which they are applied. Nevertheless the most prominent symptoms generally produced by them are those of violent local irritation; so that they may be justly considered in the place which has been assigned them.

The poisons included in this Order are the oxides and salts of Arsenic, Mercury, Copper, Antimony, Tin, Silver, Gold, Bismuth, Chrome, Zinc, Barium, Lead. Many other metals also form poisonous compounds with various acids and other bodies; but these are so rare as to be merely objects of physiological curiosity.

Of all the varieties of death by poison, none is so important to the medical jurist as poisoning with Arsenic. On account of the facility with which it may be procured in this country, even by the lowest of the vulgar, and the ease with which it may be secretly administered, it is the poison most frequently chosen for the purpose of committing murder. It is fortunate, therefore, that there are few substances in nature, and perhaps hardly any other poison, whose presence can be detected in such minute quantities and with so great certainty.

Section I.—*Of the Chemical Tests for the Compounds of Arsenic.*

Metallic Arsenic has an iron-gray colour, a specific gravity of 8.308, and a crystalline fracture. It is very brittle. It has a strong tendency to oxidate, so that it undergoes this change in air, in water, and even in alcohol. In air, particularly when moist, it becomes rapidly tarnished, a black powder being formed, which Berzelius regards as a regular protoxide*.—When exposed to heat, metallic arsenic is usually said to sublime at the temperature of 356° F.; but according to some late experiments by *Dr Mitchell* of Philadelphia this does not happen under a low red heat, luminous in the dark†. In close vessels it condenses unchanged; but when heated in the open air, it passes to the state of white oxide, and rises in white fumes. This oxide consists of one atom of metal and two of oxigen, or of 38 parts by weight of the former, and 16 of the latter.—Another oxide likewise exists, which contains three atoms or 24 parts by weight of oxigen, and which possessing strong acid properties, is denominated arsenic acid. The white oxide and the arsenic acid unite with bases, and form compounds which, with the exception of those they form with the alkalis, are mostly insoluble.—Metallic arsenic unites with sulphur in two proportions, forming an orange-red and sulphur-yellow compound. In the former, the metal being 38, the sulphur constitutes 16 parts; in the latter the sulphur forms 24 parts.—The compounds of arsenic have very little action with vegetable and animal substances.

Of the compounds which arsenic thus forms, those met with in the arts, and which it will therefore be necessary to particularize, are the following:—1. The Protoxide of Berzelius, or *Fly-powder*. 2. The Arsenious acid, or *White Arsenic*. 3. The Arsenite of Copper or *Mineral Green*. 4. The Arsenite of potass as contained in *Fowler's Solution*. 5. The Arseniate of Potass; and 6. The various Sulphurets, pure and impure, namely *Realgar*, *Orpiment*, and *King's-Yellow*.

Of the Tests for Fly-powder.

This substance is quite unknown as a poison in Britain, but is a familiar poison in France and Germany. In the former country it is termed *Poudre à mouches*, in the latter *Fliegenstein.*

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* It appears that arsenic does not always undergo this change. *Berzelius* once kept some fragments in an open phial for three years without observing any change in appearance or weight. [Annales de Chimie et de Physique, xi. 240.] *Buchner* once made a similar observation, and is inclined to think that oxidation does not occur, if the metal is quite pure. [Repertorium für die Pharmacie, xxi. 29.]

† American Journ. of Med. Science, x. 122.

It ought to be a fine grayish-black powder, as formed by exposing powdered arsenic for a long time to the air; but it also frequently contains fragments of the metal. It is usually considered by chemists to be a mixture of metallic arsenic and its white oxide.

It is acted on by water, the white oxide being found before long in solution by its proper tests. Oxidation and solution, however, are also effected upon pure metallic arsenic in the same manner. A thousand grains of water take up a grain in the course of half an hour when boiled on the metal[*].

A very simple and decisive test for the Fly-powder is derived from the effect of heat. If it is heated in a tube two substances are sublimed, first a white crystalline powder, and then a bright metallic crust, the former being the white oxide, the latter the metal. The metallic crust thus formed possesses physical properties which distinguish arsenic from all other substances: The surface next the tube is almost exactly like polished steel, being a little darker in colour, but equal in brilliancy and polish; and the inner surface is either brilliantly crystalline to the naked eye, like the fracture of cast iron, or has a dull grayish-white colour, but appears crystalline before a common magnifying lens of four or five powers. If these characters be attended to, particularly the appearance of the inner surface, it appears to me scarcely possible to mistake for an arsenical crust any other substance which can be sublimed by any of the methods for subliming arsenic. But more of this afterwards.

If a farther test should be desired, it is only necessary, as was first proposed by *Dr Turner* of London[†], to chace the crust up and down the tube with the spirit-lamp flame till it is all oxidated, when little octahedral crystals of adamantine lustre are formed, on which, either with the naked eye or with the aid of a common lens, triangular facettes may be distinguished.

The niceties to be attended to in applying the preceding tests will be considered presently under the head of the next compound, the white oxide.

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[*] *Hahnemann.* Uber die Arsenic-vergiftung, 13.

[†] Edin. Medico-Chirurgical Transactions, ii. 292.

2. *Of the Tests for Arsenious Acids.*

The Arsenious Acid or White Oxide of Arsenic, usually called White Arsenic, or simply Arsenic, is the most common and important of all the Arsenical preparations.

It is met with in the shops in two forms,—as a fine snow-white powder, and in solid masses generally opaque, sometimes translucent. When newly sublimed it is in translucent or even almost transparent masses of a vitreous lustre, conchoidal fracture and sharp-edged. By keeping it becomes opaque and white. The nature of the change has not been determined; but some alteration is certainly effected, for *Guibourt*, who has examined both varieties with care, found that the opaque variety is more soluble in water than the other. He adds that the former is alkaline, the latter acid, in its action on litmus paper; but I have always found the opaque variety acid*. The powder soon becomes analogous to the opaque variety of the oxide in mass. As now sold in the shops the powder is as fine almost as flour; which it is important to remember, since the grittiness, described in the older works as felt in the mouth, and arising from its having been coarsely powdered, will no longer be remarked so distinctly.

The oxide of arsenic has a specific gravity of 3.729, according to the experiments of *Dr Ure*. It has been incorrectly stated by some so high as 5.0. Very incorrect notions prevail as to its taste. It has long been almost universally believed to be acrid†, and is described to be so in most systematic works and in many express treatises; but in reality it has little or no taste at all. The reader will find some details on this point in a paper I have published in the Edinburgh Medical and Surgical Journal ‡. In the present work it is sufficient to observe, that I have repeatedly made the trial, and seen it made at my request by several scientific friends; and that, after continuing the experiment as long, and extending the poison along the tongue as far back, as we thought safe, we all agreed that it had hardly any taste at all,—perhaps towards the close a very faint sweetish taste. I have hitherto found only one authority who has made the observation that arsenic has no taste,—namely, *Dr Addington*, the chief crown witness on the Trial of Miss Blandy[*]; a few others, and more particularly *Hahnemann*[†], *Dr James Gordon*[‡] and *Mr Walker*[§], a witness on a late trial, have said that it is sweet; but all the other authors I have consulted mention that it is acrid[||], and one of these, *Professor Foderé*, even says that a grain causes an indescribable and insupportable metallic taste[¶]. It is impossible to make with safety satisfactory experiments on its taste when it reaches the back of the palate; but we may rest assured that it often makes no impression at all, for it has been often swallowed unknowingly with articles of food. This fact it is essential to remember, as many ignorantly believe that when swallowed even in a moderate quantity it must cause a sense of acridity. I have not been able to find any actual case where this sensation was perceived[**]; and it is therefore probable that the mistake, which the present remarks are intended to rectify, has arisen from the impression in the act of swallowing having been confounded with the inflammation in the throat subsequently developed along with the other inflammatory symptoms. And so *Navier* remarked that the solution had at first a bland taste like milk, but in a few minutes excited a sense of roughness (âpreté), and soon after the usual effects of burning[††].

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* Journal de Chimie Médicale, ii. 61.

† As far back at least as the time of Zacchias. See his Quæstiones Medico-legales, iii. 37, 11.

‡ Edin. Med. and Surg. Journal, xxviii. 96.

Before mentioning the tests for arsenic in its various conditions, it may be useful to take a general view of such of its chemical properties as are important in relation to medical jurisprudence.

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[*] Howell's State Trials, xviii. 1140.

[†] Ueber die Arsenic-vergiftung, 34.

[‡] Dissertatio Inauguralis de Arsenico, Edinburgi, 1814, p. 9.

[§] Trial of Whalley, Edin. Med. and Surg. Journal, xxix. 22.

[||] Orfila, Thomson, Henry, Thenard, Murray, Paris and Fonblanque. Orfila repeats the error circumstantially in the last edition of his *Cours de Médecine Légale*, iii. 145.

[¶] Journal Complémentaire, i. 104.

[**] Mr Blandy "perceived an extraordinary grittiness in his mouth, attended with a very painful pricking, and burning pain in his tongue, throat, stomach, and bowels." [Howell's State Trials, xviii. 1135.] Here it is evident that the taste is confounded with the subsequent inflammation. In a case mentioned in Rust's Journal the individual who was poisoned could not eat much of the poisoned dish, consisting of potatoes and beans, because it had an unpleasant taste, as if too highly seasoned with pepper [Mag. für die gesammte Heilkunde, v. 66.] This is the only account I have yet seen of an instance where a taste even approaching to acridity has been remarked.

[††] Contrepoisons de l'Arsenic, 1777, i. 21.

The oxide of arsenic when subjected to heat is sublimed at 380° or, according to *Dr Mitchell*, 425° F.[*] and condenses in the form of a crystalline powder, which, if the operation is performed slowly and on a small quantity proportioned to the size of the tube, evidently consists of little, adamantine octahedres.—When it is mixed with carbonaceous matter and heated, it is reduced, and the metal is sublimed. This constitutes the test of Reduction, which, when conducted with due care, as may easily be done, is alone a certain proof of the presence of arsenic, and is likewise a very delicate way of acquiring such proof.

Water dissolves it. Its solubility has been very variously stated by different experimentalists. This is a point, however, which it is of some consequence to determine accurately; for in cases of supposed poisoning with arsenic a doubt may arise whether the quantity of a solution that has been swallowed contained a sufficient dose to cause severe symptoms or death. The statement formerly most relied on is that of *Klaproth*, who found, that a thousand parts of temperate water take up only two parts and a half, — and that a thousand parts of boiling water take up 77.75 parts or a thirteenth, and retain on cooling 30 parts or a thirty-third of their weight [†]. The subject has been examined with great care by *Guibourt*, who has found a considerable difference between the transparent and opaque varieties in their solubility. A thousand parts of temperate water, according to his experiments, dissolve in thirty-six hours 9.6 of the transparent, 12.5 of the opaque variety; and the same quantity of boiling water dissolves of the transparent variety 97 parts, retaining 18 when cooled, but of the opaque variety takes up 115 and retains on cooling 29 [‡]. *Hahnemann* farther remarked, that at the temperature of the blood a thousand parts of water dissolve ten parts with the aid of ten minutes agitation [§], and *Navier* remarked, that boiling water kept for an hour on it and decanted off in the way an infusion is usually made, dissolves an eightieth of its weight [*].

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[*] American Journal of Medical Science, x. 122.

[†] *Schweigger's* Journal der Chemie, vi. 232.

[‡] Journal de Chimie Médicale, ii. 61.

[§] Uber die Arsenic-vergiftung, 10.

Its solubility is much impaired by the presence of organic principles in the water. When mixed with mucus or milk it dissolves, according to Hahnemann, with great difficulty; and I have found that a cup of tea, left beside the fire at a temperature of 200° for half an hour upon two grains of the oxide, does not take up entirely even that small quantity. An important consequence of the fact now mentioned is, that when swallowed in the solid state, little or no arsenic may be found in the fluid contents of the stomach. In a case which occurred to *Scheele* three grains of solid arsenic were found in the contents, but hardly a trace in solution [†]. It would be wrong, however, to suppose, that it is never found in the fluid contents. For, not to mention the observations of others, I have myself detected it five times in the fluid part of the stomach in persons poisoned by arsenic, and in one instance it amounted to a fifth of a grain per ounce.

The solution of the oxide of arsenic in boiling water yields minute crystals on cooling, which, when their form is defined, are octahedres. In this state, on account of its whiteness and brilliancy, it resembles exceedingly pounded sugar, for which it has sometimes been mistaken. By spontaneous evaporation I have procured in twelve months fine octahedres nearly as large as peas.

A difference of opinion prevails as to the action of the oxide on the vegetable colours. This is a matter of no great consequence to the medical jurist; at least I am not aware of its action on colours having ever been made use of as a test. But it is right not to leave a disputed point without some notice. The only observations which need be quoted are those of *Guibourt*, who found that the transparent variety faintly reddens litmus, while the opaque variety faintly restores to blue litmus previously reddened [‡]. My own experiments are at variance with these statements: I have always found that the solution of the powder, which is of course equivalent to the opaque variety, faintly reddens litmus, and does not alter reddened litmus.

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[*] Contrepoisons de l'Arsenic, du sublimé corrosif, &c. i. 20.

[†] Neues Nordisches Archiv. i.

[‡] Journal de Chimie Médicale, ii. 61.

The remaining chemical properties of the oxide, which it is necessary for the medical jurist to know, will be mentioned under what is now to be said of the principal tests by which its presence may be ascertained. In considering this subject I shall relate first the tests for the solid oxide, secondly, those for its solution, and lastly, the method of detecting it when mingled with vegetable or animal solids and fluids, such as the contents and tissues of the stomach. The tests and processes for the detection of arsenic in each of these states are intrinsically simple enough. But a good deal of complexity and many details must necessarily be introduced into the following narrative, on account of the obligation imposed on me of stating the real value of many tests and processes not superior, and generally inferior, in delicacy or accuracy to those I am in the custom of employing, but which are still employed by others.

Of the Tests for the Oxide of Arsenic in the solid state.

The most characteristic and simple test for oxide of arsenic in its solid state, either pure or mixed or combined with inorganic substances, is its reduction to the metallic state. This process it is requisite to describe minutely.

Various methods have been at different times proposed for employing the test of reduction. In the ruder periods of analytic chemistry we find *Hahnemann* recommending a retort as the fittest instrument, and stating ten grains as the least quantity he could detect *. Afterwards *Dr Black* substituted a small glass tube, coated with clay and heated in a choffer; and in this way he could detect a single grain †. In a paper published in the Edinburgh Medical and Surgical Journal, I showed how a sixteenth of a grain might be detected; and more lately how so minute a quantity might be subjected to this test as a hundredth part of a grain ‡.

The only instrument which should be used by the inexperienced, and the instrument which the chemist will always prefer when it is at hand, is a glass tube. When the quantity of the oxide is very small, it should not exceed an eighth of an inch in diameter, and when the material suspected to contain

* Ueber die Arsenic-vergiftung, 223.

† Lectures on Chemistry, ii. 430.

‡ Edin. Med. and Surg. Journal, xxii. 82, and Edin. Medico-Chirurgical Transactions, ii. 293.

arsenic is impure, the form of the tube should be that lately recommended by Berzelius, and represented in Fig. 3 *.

The proper material for reducing the oxide of arsenic is freshly ignited charcoal. With this substance the whole metal of the oxide of arsenic is disengaged. The black flux, which is usually recommended, is ineligible, if the quantity of oxide is very small; for only a part of the metal is disengaged, the remainder continuing in the flux, probably in the form of arseniuret of potassium. I have found that two grains of the oxide reduced with the black flux at a full red heat yield 0.635 gr. of metallic crust, instead of 1.407, or somewhat less than a half of the metal they contain. Where the quantity of material, however, is considerable, it is preferable to employ the black flux, or still better, as not being deliquescent, a mixture of charcoal and carbonate of soda deprived of water of crystallization by heat. For charcoal alone is more subject to be projected up the tube when the heat is first applied.

If the quantity operated on is large it should be mixed with the charcoal or flux before it is introduced into the tube; if on the other hand it is small, a better plan is to drop it into the tube and cover it over with charcoal. The materials are to be introduced along a little triangular gutter of stiff paper, if the tube is large; but with a small tube it is preferable to use the little glass funnel represented in Fig. 2, to which a brass or silver wire is previously fitted, for pushing the matter down when it adheres. In either of these ways the side of the tube is kept quite clean, which is a point of great consequence, especially when the black flux is used. In delicate experiments the material should not be closely impacted, or fill above three-fourths of the little ball, otherwise it is apt to be projected by the disengagement of the vapour and gas which are formed during the reduction.

By far the best method of applying heat is with the spirit-lamp, as first suggested by Mr Phillips. The upper part of the material ought to be heated first, and with a very small flame. Afterwards the heat should be applied to the bottom of the tube, the flame being previously enlarged by drawing out the wick with a pair of forceps. A little water, disengaged

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* Arsberättelse, &c. 1825, p. 111. Tubes of this form are easily made with the spirit-lamp flame without the blowpipe.

in the first instance, should be removed with a roll of filtering paper, before a sufficient heat is applied to sublime the metal. As soon as the dark crust begins to form, the tube should be held quite steady, and in the same part of the flame. By these precautions a well defined crust will be procured with facility even by a mere tyro in practical chemistry, as I have ascertained by repeated trials.

The characters of the crust have been mentioned already under the head of Fly-powder (p. 231.) They are distinct even in small crusts: I have found them quite obvious in one which weighed only gr. 0.0035 or a 286th part of a grain. In this observation I am borne out by the high authority of Berzelius, who says that a 190th of a grain of the oxide is more than sufficient to yield a good crust,—that he has procured a metallic crust from a quantity imperceptible to any of his balances *. In order that a person unaccustomed to delicate chemical manipulations may comprehend how the physical qualities of so minute a particle can be recognized, it may be mentioned that the crust, although quite opaque, is exceedingly thin, and is therefore extended over a proportionately large space. In the experiment just related it occupied a tenth of an inch in a tube an eighth in diameter, and consequently covered a surface equivalent to the following parallelogram ▭. The whole of this surface was resplendent and polished externally, and crystalline internally before a microscope of four powers. I am particular in these details,—because the attention of chemists has been too exclusively directed to the delicacy of the liquid tests, whereas the test of reduction is of equal or superior delicacy,—and still more, because persons unacquainted with chemical analysis are apt to be startled when they hear of a medical jurist deciding on the presence of arsenic from a crust of a twentieth or even a tenth of a grain in weight. A crust weighing a twentieth of a grain, when properly formed, exhibits the physical properties of arsenic to the naked eye with as great distinctness as any quantity, however large. It may be well for the medical witness, when he finds the accuracy of his process questioned on the ground of its minuteness, to remind the court of the minute quantity in which the properties of gold leaf may be at once recognized by the vulgar, although its pro-

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* Arsberättelse, &c. p. 111.

perties are by no means so characteristic as those of a sublimed arsenical crust. Another good illustration may be taken from the minute accuracy of the hydrostatic balance. The most inexperienced may be satisfied by two minutes' inspection that a fine balance will distinctly show the weight of a thousandth part of a grain of arsenic: and surely if such a piece of mechanism can be constructed, it is not at all wonderful that a chemist should exhibit the other properties of the metal with nearly equal minuteness and certainty.

After these statements regarding the delicacy of the test of reduction,—which are peculiarly essential, as it is the test which in a subsequent part of this section will be applied to the detection of arsenic in all possible states of admixture,—some notice must be taken of the several fallacies which have been supposed to render it equivocal.

Here I cannot help expressing my surprise that authors of such eminence as Dr Paris, Dr Smith, and Dr Beck should have undervalued the accuracy of the test by reduction*. They seem to concur in considering it, although the best of all, yet liable to certain fallacies which render it not decisive, when taken alone; whereas the great excellence of the test is, that the sublimed crust possesses so many highly characteristic properties, as to render it equivalent to many other tests taken conjunctly, and to put it absolutely beyond the reach of every fallacy. The reason why these and other authors have allowed themselves to depreciate it has apparently been, that they did not attend to the internal appearance of the crust, or its conversion by heat into the oxide, neither of which properties is mentioned in any of their works, although either property is more characteristic than the polished metallic brilliancy of the outer surface.

The fallacies to which the test has been supposed to be liable, (excluding at present that part of it which consists in the oxidation of the metal, and which renders it quite unimpeachable,) are the following.—*Dr Paris* says he has known an instance where a person, " by no means deficient in chemical address," mistook for it a deposit of charcoal†, and I have known the same mistake happen in the hands of one of my pupils, a beginner in the study of medico-legal chemistry. The outer surface of a charcoal crust may be mistaken for arsenic by a careless person; but with ordinary care it is quite impossible to err if the inner surface is examined, for that of charcoal is brown, powdery, and perfectly dull.—It has been suggested to me by many of my friends, and has also been stated in print[*], that the preparations of antimony yield by reduction a sublimate resembling closely the crust formed from the preparations of arsenic. In point of fact, antimony really undergoes a sort of spurious sublimation under peculiar circumstances, as will be mentioned in the section upon that poison; but in consequence of repeated trials I am certain that no preparation of antimony when reduced either by charcoal or the black flux with the fullest red heat of the blowpipe will yield any metallic sublimate; and the same facts have been observed by my friend Dr Turner. It is absurd, therefore, to talk of the presence of antimony as any fallacy in the way of the detection of arsenic by the process of reduction.—It has even been said by *Mr Donovan* that the action of the flux on glass which contains lead causes a stain somewhat similar to an arsenical crust[†]. If it is meant by this observation that the lead contained in the glass usually gives that part of the tube which contains the flux a glimmering appearance and impairs its transparency, I believe the author is correct: but if any one conceives that a sublimate can be so formed, I must repeat, as in the case of antimony, that the thing is altogether impossible.—*Dr Mitchell* of Philadelphia in an elaborate paper on the process of reduction seems to consider the crust undistinguishable from that formed in similar circumstances by cinnabar. I cannot agree with this opinion, having often examined small crusts of cinnabar, and never remarked the internal surface to present the peculiar character possessed by a crust of arsenic[‡].—Zinc, it is said, may be sublimed in its metallic state; but this fallacy is not of any consequence, for the sublimation of zinc requires a full white heat, much fuller than can be commanded by the lamp even aided with the blowpipe: which in the process for arsenic is never necessary.—Tellurium, cadmium, and potassium sublime at a much lower heat; but these metals are so exceedingly rare, that it is quite unnecessary to particularize the characters of their sublimates.

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* Paris and Fonblanque's Medical Jurisprudence, ii. 250. Smith's Forensic Medicine, 104. Beck's Medical Jurisprudence, London Edition, 409.

† Paris and Fonblanque, 251.

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[*] *Donovan* in Dublin Phil. Journal, ii. 402. [†] Ibid.

[‡] American Journal of Medical Science, x. 126.

Some notice ought to be here also taken of a very extraordinary fallacy which was lately charged against this test in remarkable circumstances,—namely that a minute arsenical crust may be formed from arsenic contained in the glass of the tube. A few years ago *MM. Ozanam* and *Idt* of Lyons detected arsenic in the remains of a body which had been seven years interred; but subsequently M. Idt imagined he had discovered that the glass used in the analysis contained arsenic, and yielded a little by the process of reduction with potass and charcoal. He accordingly retracted his original opinion, and in consequence of his evidence at the subsequent trial of the person accused of administering the poison an acquittal was obtained. M. Ozanam, however, having adhered to his first opinion, an extended inquiry was undertaken by the Parisian Academy of Medicine at the request of the French government; and the result was that no arsenic could be detected in the glass tubes used by MM. Ozanam and Idt;—that although arsenic is sometimes used in glass-making, it cannot be detected by any process of analysis in any of the clear glass met with in commerce, the whole arsenic being volatilized during the manufacture of the glass;—that a small portion of arsenic is retained in some opake glasses or enamels;—but that even in them it cannot be separated by the process of reduction except in very refractory green-glass tubes, which resist a very powerful heat*.

To conclude, then, it may be safely laid down that the appearances exhibited by a well-formed arsenical crust, even in the minute quantity of a 300th part of a grain, are imitated by no substance in nature which can be sublimed by the process for the reduction of arsenic.

In case any one should nevertheless desire to have some farther evidence of the nature of the crust, he may easily satisfy himself by subjecting it to the test of oxidation by heat, which has already been briefly mentioned.

The best method of applying this part of the test is to heat the ball containing the flux deprived of arsenic, to attach a bit of glass tube to its end, and to draw it gently off in the spirit-flame, taking care to prevent the flux being driven forward on the crust. This being done, the whole crust, or, if it is large, a portion of it, is to be chaced up and down the tube with a small spirit-lamp flame till it is all converted into a white powder. In order to show the crystalline form of the powder distinctly, let the flame be reduced to the volume of a pea by drawing in the wick, and let the part of the tube containing the oxide be held half an inch or an inch above it. By repeated trials sparkling crystals will at length be formed, which are octahedres,—the crystalline form of arsenious acid. The triangular facettes of the octahedres may be sometimes seen with the naked eye, though the original crust was only a fiftieth of a grain or even less; and they may be always seen with a lens of four powers, the tube being held between the eye and a lighted candle or a ray of sunshine, either of which is preferable to diffuse daylight for making this observation. For the success of the oxidation test it is indispensable that the inside of the tube be not soiled with the flux, if the flux contained an alkali; because the alkali would unite with the oxide. It is also requisite not to heat the tube suddenly so as to redden it before the oxide is sublimed; because then the oxide is apt to unite with the glass, forming a white, opaque enamel.—*Dr Mitchell* in his strictures formerly referred to [240,] says in regard to this supplementary test, that "it is with a very little arsenic more easily described than executed." I cannot comprehend how he should have arrived at such a conclusion, more especially in the very circumstances he mentions, because the production of a crystalline powder, composed of minute, yet distinguishable octahedres, has appeared to me most easy where the arsenic was very small in proportion to the size of the tube.

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* Annales d'Hyg. Pub. et de Méd. Lég. xi. 224.

It is worthy of remark, that the characters of the oxide may sometimes be distinctly exhibited, although those of the metallic crust from which the oxide is formed are not satisfactorily presented. This once happened to myself in a medico-legal case, where the sublimed metal was excessively small in quantity and too much spread over the tube. At other times, too, as I have had occasion to observe, the metal, if its quantity is very minute, is oxidated at once in the act of subliming, and never presents the appearance of a metallic crust. Although the characters of the crystalline oxide in either of these cases are very precise and distinctive, it may be right to subject it to a farther test when the metal is not previously exhibited with its characteristic properties. For this purpose it is sufficient to cut away with a file the portion of the tube which contains the crystalline sublimate, to boil it in another tube with a few drops of distilled water till the sublimate is all dissolved, and then to test the solution with one of the fluid tests to be presently described, the ammoniacal nitrate of silver.

Such is the best and only process I should recommend for the detection of arsenic when in its solid form. It is proper, however, to notice shortly some other tests which have been proposed for the same purpose,—not that it is either necessary or useful for the medical jurist to employ any of them in actual practice, but because he may have to state his opinion regarding their validity when employed by persons of less skill and knowledge.

1. The first is its alliaceous or garlicky odour. The test derived from the strong and peculiar smell of arsenic was at one time much relied on. It appears, indeed, to have been during the third quarter of last century almost the only one in use. From several inspections recorded in *Schuster's* Medical Journal in the year 1767–74, and from a case related by *Professor Metzger* [*], we learn that it was then the practice to decide as to the existence or non-existence of arsenic in the contents of the stomach, simply by the odour of the dried residuum when burnt. Nay, a respectable author of the same period has even said, that, in the event of other means failing, good evidence might be procured by burning the whole body, and observing the smell which arises [†]. The garlick odour is evolved by the sublimation of metallic arsenic only, never by the oxide, unless it is at the same time reduced. In consequence of its easy reduction, however, the odour in question is often exhaled, when an inexperienced person would believe it came from the oxide. Thus it is exhaled when the oxide is projected not only on coals, but likewise, as *Dr Paris* remarks [‡], on red hot copper, or iron, or on melted zinc, or even when it is held on platinum in the spirit-lamp flame, if the flame is allow-

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[*] Materialien für die Staatsarzneikunde, i. 133.

[†] *Reisseisen.* De Veneficio doloso, in Schlegel's Collectio Opusculorum, iii. 142.

[‡] Medical Jurisprudence, ii. 214.

ed to come in contact with the material. In all these cases there is reduction: The oxide placed on iron, copper, glass, or platinum, and then heated, never emits alliaceous fumes.

This test should be altogether discarded. It does not always detect arsenic when present; and the alliaceous odour is not an infallible proof that it is present. Zinc powder projected on burning fuel emits the same odour*: Phosphorus, phosphoric acid, and the phosphates give out a similar odour†: I have frequently remarked one very like it from burning paper: And burning animal matter occasionally exhales an odour which may be mistaken for it, as actually happened indeed in the course of a late medico-legal examination at Paris‡. What is of more consequence, however, a very small portion of vegetable or animal matter present in the matter subjected to trial obscures the alliaceous smell entirely. This I have often observed, and the same thing was stated long ago by *Pyl* and *Hahnemann* §. If any one should nevertheless wish to have recourse to this test, the proper way to try it is to breath gently with the nostrils into the tube immediately after the metal has been sublimed, and then to smell it.

2. The next test for solid arsenic is the production of a silvery alloy, when the oxide is mixed with carbonaceous matter and heated between two copper plates. This test is now very little used. *Dr Bostock* has stated, that an appearance somewhat similar is caused by charcoal only ||; and *Dr Beck* observes, on the authority of his countryman, Dr Macniven, that oxide of tin has nearly the same effect on copper as the oxide of arsenic has ¶. The most material objection, however, is, that a characteristic alloy cannot easily be procured with less than a grain, a quantity which is sufficient for trying much better tests ten times over. The proper method of applying it is to mix the suspected substance with the black flux, to place it on a plate of copper, surround it with a ring of flux, bind another plate of copper over it with iron wire, and expose the whole for three or four minutes to the heat of a common fire. On rubbing

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* *Pyl's* Aufsätze und Beobachtungen, i. 63.

† *Hahnemann*, Uber die Arsenic-vergiftung, 217.

‡ *Devergie*, Dictionnaire de Méd. et de Chir. pratiques, art. Arsenic, iii. 328.

§ Pyl. i. 63. Hahnemann, 218.

|| Edin. Med. and Surg. Journal, v. 172.

¶ Medical Jurisprudence, 412.

the plates with ashes to clean them, the silvery alloy will be seen distinctly.

3. A very simple and satisfactory test for the oxide in its solid state, which might be advantageously used if any other test were necessary besides reduction, is the conversion of the oxide into the arsenite of copper, when it is kept for a few hours in a solution of the ammoniacal sulphate of copper, a fluid reagent which will be described presently. The oxide of arsenic is gradually converted into an apple-green powder, in consequence of its uniting with the oxide of copper to form the arsenite of that metal, while the blue solution of the cupreous salt becomes colourless. No other substance in nature exhibits the same phenomena with this reagent. The ammoniacal sulphate of copper might likewise be used to determine the nature of a doubtful arsenical crust. If the crust be immersed in a diluted solution of the ammoniacal sulphate, it will either acquire in a few hours a green colour, or, if it is small, it disappears, and a resplendent green film is formed on the surface of the fluid, the metallic arsenic being oxidated, and then combining with the oxide of copper. But the test of oxidation by heat described above is much simpler, and more characteristic.

4. An ingenious and simple mode of applying the ammoniacal sulphate of copper as well as the ammoniacal nitrate of silver to the detection of solid oxide of arsenic has been proposed by *Dr Murray* of Aberdeen. He proposes to press the oxide in powder by means of a glass rod into common writing-paper, to touch the spot with a drop of solution of sulphate of copper or nitrate of silver, to place the paper so prepared over a phial of ammonia and to expel the ammoniacal gas through the paper by plunging the phial in hot water. The peculiar green and yellow colours speedily appear, which, as will be presently seen, are characteristic of the action of the copper and silver tests on arsenic in solution. *Dr Murray* thinks this method will supply equally strong proof of the presence of arsenic with the process of reduction [*]. But I apprehend few medical jurists will adopt that opinion in practice, or neglect the method by reduction wherever it is applicable.

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[*] Edinburgh Med. and Surg. Journal, xli. 365.

Of the Tests for the Oxide of Arsenic in a state of solution.

The oxide of arsenic when in solution may be detected in two ways; by a process, the ultimate object of which is to exhibit metallic arsenic; and by what are called the liquid tests.

Reduction-process.—The former of these processes was proposed in a paper which I published in the Edinburgh Medical and Surgical Journal for July 1824. Its advantages over the fluid tests in regard to a solution of pure oxide, or of that mingled with other mineral substances, are that it presents the same portion of arsenic successively in three characteristic forms, while the process by the liquid tests requires a separate portion for each; and that, resting on the evidence furnished by the reproduction of the metal and oxide, its indications, while they are at least equally infallible, are more easily appreciated with exactness by the chemist as well as the unprofessional. It will be afterwards seen that for vegetable and animal fluids it possesses other advantages of not inferior importance.

The plan which has appeared to me the most perfect and at the same time the most easily managed by an unpractised operator, is to throw down the whole arsenic in the form of sulphuret by means of sulphuretted-hydrogen, to convert the sulphuret by the process of reduction to the metallic state, and to oxidate the metal thus procured. The sulphuretted-hydrogen is preferred to other liquid reagents, because the precipitate it forms, while possessing a very characteristic colour, is also more bulky than those caused by the other tests, and is therefore more easily collected when minute in quantity,—and because its action, as will be seen presently, is not liable to be prevented or obscured by so many disturbing causes. The steps of the process are the following.

The fluid to be subjected to trial must be neutral, or acidulated with a vegetable acid. If the fluid is alkaline, the sulphuretted-hydrogen will not act, because the precipitate it would otherwise form is soluble in the alkalis. If, on the other hand, a mineral acid, at least nitric or sulphuric acid, be present in excess, an excess of sulphur is thrown down, which might subsequently prevent the process of reduction from succeeding. Hence if the fluid reddens litmus, and the acid is either unknown or a mineral acid, it must be neutralized with potass:

If it is alkaline it must be acidulated with acetic or muriatic acid: and it is well to acidulate in all cases. Sulphuretted-hydrogen has no action on diluted acetic or muriatic acid. The fluid being thus prepared, it is to be subjected to a stream of sulphuretted-hydrogen gas for ten or fifteen minutes. This is procured by placing a small quantity of sulphuret of iron along with a little water in the apparatus, Fig. 5, and pouring into the funnel successive portions of sulphuric acid. The first portions of the gas turn the arsenical solution to a bright lemon-yellow colour, and the subsequent portions throw down a flocculent precipitate of a sulphur-yellow tint, which is the sulphuret of arsenic,—the sulphur of the reagent uniting with the metal of the oxide, while the hydrogen of the former unites with the oxygen of the latter to produce water. If the proportion of oxide in solution is small, no precipitate, but only a yellowness or yellow milkiness is caused, owing to the sulphuret being soluble in an excess of sulphuretted-hydrogen. An essential step in the process, therefore, is to expel that excess by boiling; upon which a distinct precipitate and colourless fluid are produced. The precipitate is then to be collected and dried. When the quantity is minute this is done as follows. The precipitate is allowed to subside, and after the supernatant fluid has been withdrawn, the remainder is poured into a filter. When all the fluid has passed through, the portions of precipitate on the upper part of the filter are washed down to the bottom by means of the instrument represented in Fig. 6. The filter is then gently compressed between folds of bibulous paper, and the sulphuret removed with the point of a knife before it dries, and dried in little masses on a watch-glass by the side of a chamber-fire, or still better in a vapour-bath. In this way it is very easy to collect a twenty-fifth part of a grain of the sulphuret.—Another method which takes more time, but will enable the least skilful person to collect extremely small quantities, is to allow the sulphuret to subside in the original fluid in which it is formed, to pour off the supernatant liquid, and pour the remainder into a small glass tube, Fig. 7. After the precipitate has thoroughly subsided, the supernatant liquid is to be withdrawn, and its place filled up with boiling water. The operation of alternate subsidence and affusion being repeated a sufficient number of times, the last portions of water should be gently driven off by heat and wiped off the inside of the tube as the drops condense on it. Finally, the bottom of the tube with the precipitate attached is to be cut away with the file, and broken into small fragments with the view of preserving the whole sulphuret for the process of reduction.—The sulphuret having been collected in either of these ways, it is now to be dropt into the tube, Fig. 3, and covered by means of the funnel, Fig. 4, with a flux, consisting of an alkaline carbonate and charcoal. That usually employed is the black flux, which should be made by deflagrating in a crucible one part of nitre with two parts and a-half of supertartrate of potass; but a more convenient flux for the unpractised, as being not deliquescent, is a mixture of two parts of ignited carbonate of soda and one of charcoal. The part of the tube containing the flux ought to be heated first. The process in other particulars is the same with that for the reduction of the oxide.

The carbon of the flux is not essential in the process, but it is useful by increasing the quantity of the sublimate: I have found that after the sulphuret of arsenic has been exposed to a full red heat with carbonate of soda, it gives out as much arsenic again when the residue is mixed with charcoal and heated afresh. A similar observation has been made by Mr Phillips. Berzelius, however, has very correctly observed in some criticisms on the preceding process in his Yearly Retrospect of Chemistry for 1825, that even with the aid of charcoal the whole of the arsenic is not disengaged from the sulphuret. I have found that three grains of the sulphuret prepared by passing sulphuretted-hydrogen through a solution of the oxide, yield when reduced by means of black flux with the full red heat of a large blowpipe flame only 0.67 instead of 1.84, or not much more than a third; and that two grains of native orpiment reduced with the soda flux yield 0.424, instead of 1.226. This Berzelius believes to be owing to the arsenic being retained in the form of an arseniuret of potassium or sodium *.

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* Berzelius has proposed to convert the sulphuret into another compound previous to reduction, the arseniate of lime, which he directs to be reduced by charcoal. This is effected by a process to be mentioned afterwards among the various methods which have been proposed for detecting arsenic in organic fluids. At present it is sufficient to observe, that, independently of the additional complexity of the process, *Berzelius* appears to be in error when he says, that the arseniate of lime is all decomposed and the whole arsenic expelled by reduction with freshly-ignited

Process by Liquid Reagents.—The second process by which oxide of arsenic may be detected in solution is by the employment of several Liquid Tests, which cause in the solution peculiar precipitates. Many such tests have been proposed; but those which are most characteristic in their action, and which are sufficient for the purpose in view are the *Sulphuretted-hydrogen*, the *Ammoniacal Nitrate of Silver*, and the *Ammoniacal* Sul*phate of Copper*. These three reagents will now be examined particularly as forming conjunctly the best process by liquid tests. The other fluid reagents will be shortly noticed afterwards.

The indications of each of the three tests must concur, otherwise one can hardly be entitled to speak with certainty to the existence of arsenic. But when they do concur, the evidence they furnish is unimpeachable; at least no other substance or mixture of substances is known which has similar effects on them all. In the following description of them the conditions required for their operation will be noticed particularly. The fallacies to which they are exposed are much less important than is generally pretended, because the employment of the tests in conjunction renders the analyst independent of their fallacies. These fallacies, therefore, though usually dwelt on at great length, will be discussed very cursorily.

Sulphuretted-hydrogen is used as a fluid test in the way described above [p. 246.] An excess of alkali must be neutralized with acetic acid; and an excess of nitric or sulphuric acid with potass. If the solution is much diluted, the precipitate remains dissolved in the excess of sulphuretted-hydrogen, form-

charcoal. I find that gr. 1.033 of arseniate of lime treated in this way and heated before a large blowpipe flame till the whole ball was fused and till no more sublimate was evolved, yielded only 0.134 instead of 0.436, or hardly one-third of its actual metal. It is probable, therefore, that an arseniuret of calcium is formed in the present case like the arseniuret of potassium in the former instance. This is a difficulty to which probably most of the insoluble salts of the arsenious and arsenic acids are liable. The arseniate of lead I have found to be similarly circumstanced: A grain of arseniate of lead yields only 0.120 instead of 0.218 of arsenic when it is reduced with charcoal.—Very lately *Mr Venables* of Chelmsford has stated that the arseniate of silver is not so liable to this objection, as it yields with charcoal and boracic acid half as much more than the arseniate of lead [*]. But in some trials I have made with this salt, it has appeared to me so refractory even in the full-red heat of a large blowpipe flame, that I cannot recommend the substitution of it for the arseniate of lime in the process of Berzelius.

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[*] London Med. Gazette, viii. 806.

ing a yellow fluid; but it separates after ebullition, or a few hours' exposure to the air. Animal and vegetable principles sometimes enable the fluid to retain a minute portion even after ebullition, so as to acquire a yellow milkiness; but they do not in any case prevent the test from producing the yellow colour. Acidulation with acetic acid favours its subsidence in all cases, and is therefore a useful preparative addition before transmitting the gas. *M. Boutigny* has observed that muriatic and oxalic acid, as well as the alkaline sulphates, muriates and nitrates have the same effect *. Sulphuretted-hydrogen is an exceedingly delicate test, as it acts on the oxide in a hundred thousand parts of water. The proper colour is lemon or sulphur-yellow. The presence of vegetable or animal matter commonly gives the yellow a whitish or brownish tint.

It is not liable to any material fallacy. The salts of cadmium yield with it precipitates nearly of the same colour: But they are exceedingly rare; and besides the precipitated sulphuret of cadmium, unlike the sulphuret of arsenic, is insoluble in ammonia, and soluble in muriatic acid with the aid of brisk stirring.—The salts formed by selenic acid, if decomposed by another acid, also yield yellow precipitates with sulphuretted-hydrogen; but these salts are extremely rare.—The per-salts of tin give a dirty grayish-yellow precipitate: But this is easily distinguished from sulphuret of arsenic by the effect of ammonia, which turns it brown.—The salts of antimony do not form, as is commonly said, any source of fallacy, the precipitate caused in them by sulphuretted-hydrogen being always orange-red, never lemon or sulphur-yellow: Among the innumerable experiments I have made it has never occurred to me to observe the sulphuret of antimony assume the yellow colour of sulphuret of arsenic; and the experience of Dr Turner is to the same effect †.—A strong excess of sulphuric, nitric, or phosphoric acid causes with sulphuretted-hydrogen a pale yellowish white precipitate of sulphur, though arsenic is not present: The production of such a precipitate, however, has been provided against above; and besides the precipitate is not like sulphuret of arsenic.

Various other methods besides that now described have been proposed for procuring the precipitated sulphuret of arsenic as an indication of the presence of the oxide. Orfila and the French medical jurists use sulphuretted-hydrogen water. This has no advantage in point of convenience over the gas, as it is with difficulty preserved free from muddiness; and has the disadvantage of diluting the solution. The German medical jurists have made frequent use of the hydrosulphate of ammonia, an acid being also added to the suspected solution, so as to free the sulphuretted-hydrogen when the test comes in contact with the arsenic. But two objections lie against the hydrosulphate of ammonia: If not well charged with sulphuretted-hydrogen, the excess of ammonia keeps the arsenical sulphuret in solution; and the acid which is necessary to the action of the test will cause with it a pale yellow precipitate, though arsenic be not present. The solution of liver of sulphur, sometimes used by the inexperienced, is altogether out of the question: It causes a yellowish-brown precipitate.

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* Journal de Chim. Méd. viii. 449.

† Edin. Medical and Surgical Journal, xxviii. 73.

The *Ammoniacal Nitrate of Silver* is prepared by precipitating the oxide of silver by means of ammonia, from a solution of nitrate of silver or lunar caustic in ten parts of water, and then redissolving the precipitate nearly, but not entirely, by adding gradually an excess of ammonia. When thus prepared, it causes, even in a very diluted solution of the oxide of arsenic, a lively lemon-yellow precipitate, passing to dark brown under exposure to the light. The chemical action is simple; the ammonia unites with the nitric acid, and the two oxides with one another, to form arsenite of silver. The action of this test is prevented by the presence of nitric, acetic, citric, or tartaric acid in excess, particularly by the first and last. It is also prevented by an excess of ammonia. Nay it is even prevented in very diluted solutions by the nitrate of ammonia, though perfectly neutral. These facts will suggest the necessity of certain obvious precautions, which need not be mentioned. Its action is likewise obscured by the co-existence of various salts, in which when pure the nitrate of silver causes a white precipitate; for the yellow colour is then very much lessened in intensity. The only salt requiring special notice, because it occurs in very many of the fluids which are likely to be subjected to the researches of the medical jurist, is common sea-salt, the chloride of sodium. A moderate proportion of this salt gives the arsenical precipitate a pale yellowish-white colour. The best way of getting rid of this difficulty is to use in the first instance, not the ammoniacal nitrate, but the nitrate of silver, as long as any white precipitate falls down, to add a slight excess of that test, and then, after subsidence, to drop in ammonia. No arsenic is thrown down by the first steps of this process; but if any be present, it is subsequently thrown down in the form of the rich yellow arsenite of silver, on the addition of ammonia. This very simple mode of getting rid of the chloride of sodium was first proposed by *Dr Marcet* *. The ammoniacal nitrate of silver is of no use whatever as a test for a moderately diluted solution of the oxide of arsenic, if vegetable or animal matter is present; either the colour of the precipitate is essentially altered, or no precipitate is formed at all, the organic principles in the solution having a solvent power over it. These facts were first stated by me in 1824†; and I have since had occasion to verify them in every judicial case in which I have been engaged.

If the presence of arsenic is to be inferred only when the full lemon-yellow colour of the precipitate is developed, this test is not liable to any material fallacy. The presence of a phosphate, which was a serious obstacle in the way of the old method of using the silver test, is not a source of fallacy in the instance of the ammoniacal nitrate; for the phosphate of silver is so soluble in the ammonia of the test, that no precipitate is caused unless the phosphate in solution is very abundant. In that case, however, a yellow precipitate is formed.—The original way of using the salt of silver as a test for arsenic was by adding potass to the arsenical solution, and then dropping in the nitrate of silver: But with this form of the test a phosphate in solution is a material fallacy, as the yellow phosphate of silver is thrown down by it. Afterwards ammonia was substituted for the potass; and subsequently the ammonia, instead of being added to the arsenical solution, was more conveniently added to the test. In that way the ammonia may be used so as to prevent the risk of an excess, which would keep the arsenite of silver dissolved. The silver test was proposed by *Mr Hume*, a chemist of London; and in its improved state was suggested by the late *Dr Marcet*. *Orfila* [*], in his earlier writings, *Hink* [†], and other foreign authors have fallen into the error of supposing that nitrate of silver without an alkali precipitates oxide of arsenic; and (in consequence, I presume, of their mistatements,) I have met with several instances of the same mistake in medico-legal practice. Without an alkali, pure nitrate of silver gives no precipitate with oxide of arsenic, or at most a bluish-white or yellowish-white haze when both are concentrated.

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* London Med.-Chirurgical Transactions, iii. 342.

† See Edin. Med. and Surg. Journal, xxii. 60, where the fallacies to which the liquid tests are liable are investigated at great length.

Although the ammoniacal nitrate of silver cannot be relied on when applied to organic fluids, it is even for them an exceedingly convenient trial-test: If on a small quantity placed in a tube this test acts characteristically, the analyst may be sure he will find a large quantity of arsenic by the Reduction-process.

The *Ammoniacal Sulphate of Copper* is prepared by the same process with the last test, sulphate of copper being substituted for nitrate of silver. It is a test of very great delicacy. It causes in solutions of the oxide of arsenic a precipitate of an apple-green or grass-green colour. The particular tint is altered apparently by trifling circumstances; but after the precipitate has stood some hours it always assumes a tint intermediate between apple-green and grass-green. The chemical action consists in the union of the ammonia with the sulphuric acid, and of the oxide of copper with the arsenious acid. The operation of this test is prevented by hydrochloric, nitric, sulphuric, acetic, citric, and tartaric acids in excess. It is likewise prevented by an excess of ammonia. These difficulties are obviated by manifest precautions. It is also prevented, according to *Hünefeld*, by muriate, nitrate, and sulphate of ammonia [‡]. It is also prevented by almost all vegetable infusions and animal fluids, when the oxide of arsenic is not abundant; and this difficulty cannot be obviated. Even when not prevented by such fluids, its operation is often obscured, the precipitate not possessing its characteristic colour.

The ammoniacal sulphate of copper is more open to fallacies than the silver test. Of these the most important is that in some organic fluids it strikes a green precipitate, like the arsenite of copper, though arsenic is not present*. The solution of Bichromate of potass is turned green but not precipitated by it.

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[*] Toxicologie Générale, i. 360, corrected in his Cours de Méd. Lég. 1832.

[†] Ueber Arsenic, 45.

[‡] *Horn's* Archiv. für Medizinische Erfahrung, 1827, i. 230.

The cupreous test has been used in various other forms. The first way in which it was used in Britain was by adding potass to the arsenical solution and then dropping in the sulphate of copper: But by that method a blue oxide of copper is thrown down, which in organic fluids has generally a green tint, although arsenic is not present. Another method, and a convenient one, lately suggested by *Mr Phillips*, is to precipitate the sulphate of copper with potass, and to add to it the arsenical fluid: A blue oxide of copper is first thrown down, which is turned green on the addition of the solution of arsenic. Here too, however, an organic fluid is apt to act like an arsenical one, by turning the blue into green. A third method, once used in Germany, is to dissolve the oxide of copper in ammonia: But this solution is decomposed even by distilled water. The acetate of copper has likewise been proposed, and it acts without the aid of an alkali; but it is not so delicate a reagent as the ammoniacal sulphate.

Such are the most characteristic of the fluid tests for arsenic. On reviewing all that has been stated regarding them, it will appear that there is no single test on which thorough reliance can be placed; but that the fallacies to which they are liable apply each to one test only. Hence if each of the three reagents, when applied with due care, gives a precipitate of the characteristic tint, the proof of the presence of arsenic is decisive. This particular view of the indications of the liquid tests, however obvious it may seem, has been generally overlooked by the numerous chemists and medical jurists who have written for and against them. The antagonists of the tests have been content with proving how so many fallacies lie in the way of each, that no dependence can be put in any of them individually: They have not considered that the fallacies attached to one are obviated by the conjunct indications of the others.

The process, however, for detecting arsenic in solution by precipitation with sulphuretted-hydrogen, and successive reduction of the sulphuret and oxidation of the metal, although not perhaps more conclusive, possesses many advantages over the method by fluid tests. In the first place, though not more conclusive in the opinion of a chemist, it must obviously be more satisfactory to the mind of an unpractised operator, and still more to the unscientific minds of a criminal court and jury,—an object which every medical jurist should keep in view, and which no one who has been engaged in medico-legal practice can lose sight of. Then it is more simple, as only a single series of precautions must be borne in mind and observed. Next, it may often be of signal utility, by enabling the medical inspector to lodge in evidence a portion of the arsenic as administered. And lastly, as will be seen presently, it is applicable, with one or two slight variations, to the detection of the poison in the most complex animal and vegetable fluids, in the examination of which the method by liquid reagents is apt to lead to erroneous conclusions.

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* Edin. Med. and Surg. Journal, xxii. 74.

Some other tests which have been proposed for oxide of arsenic in solution may be noticed here. But they are all unnecessary, and either less convenient, less delicate, or less conclusive than those already described.

Three other liquid tests may in the first place be mentioned, namely, lime-water, chromate of potass, and the compound of iodine and starch.—*Lime-water* precipitates oxide of arsenic white, an arsenite of lime being formed. But it likewise acts similarly on the carbonates, phosphates, oxalates, tartrates, and their acids, and consequently also on many vegetable infusions and animal fluids. Farther, it does not act on the oxide when the solution contains free hydrochloric, nitric, or acetic acid; it does not act delicately, according to *Hünefeld*, if there is any sulphate, muriate, or nitrate of ammonia present*; and it likewise fails to throw down arsenic from some animal fluids, though they are not acid. In the last place, independently of what has been said, it is quite inapplicable to organic fluids, because when it does throw down the oxide from them, the precipitate is rarely white, but grayish, yellowish, or brownish. Lime-water, then, though in common use, is very ineligible. —The *Chromate of Potass* was proposed not long ago by Dr Cooper of the United States. It causes slowly a green precipitate, the protoxide of chrome, the chromic acid being partially deoxidated by the arsenious acid [*]. The relations of this test have not been particularly examined.—The blue compound of *iodine* and *starch* is turned red, according to *Brugnatelli*, by the solution of oxide of arsenic [†]. This is an insignificant test, which hardly deserves mention.

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* *Horn's* Archiv, &c. 1827, i. p. 230.

Besides the Reduction-process recommended above, (p. 246,) two other methods have been devised for the same purpose.—*Dr A. T. Thomson*, taking advantage of the property possessed by animal charcoal of absorbing various salts from their solutions, has proposed to remove the oxide of arsenic in this way from fluids containing it, and to reduce and sublime the metallic arsenic by drying and heating the charcoal [‡]. This very simple process, however, will not answer when the proportion of the oxide is small; for the whole of the oxide is not removed from the solution, and the quantity of charcoal required is so great that it cannot be introduced into the small tubes which must be employed for showing minute arsenical crusts characteristically.

The agency of Galvanism has been resorted to for the same purpose by *Jaeger*, subsequently by *Fischer* [§] and *Torosiewitz* [||], and still more recently by *Mr Edmund Davy* [¶]. The method adopted by the German chemists is as follows. In a little glass jar three or four inches deep, and an inch in diameter is suspended, by means of a perforated cork fitted to the mouth of the jar, a small glass tube three inches long, half an inch in diameter, and covered at its lower end with bladder. Between the tube and side of the jar is a semicylindrical plate of zinc nearly as long as the jar is deep; and the upper end of this plate, which is cut small for the purpose, perforates the cork of the jar. The little tube has a cork fitted to it, through which a moderately thick platinum wire passes nearly to the bladder at the bottom of the tube. The arsenical fluid being poured into the central tube, and a solution of muriate of ammonia or lime into the jar around the tube, the upper end of the platinum wire is brought in contact with the upper end of the zinc plate.

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[*] *Beck's* Medical Jurisprudence, 407.

[†] Annals of Philosophy, x. 151.

[‡] London Dispensatory, p. 176.

[§] *Schweigger's* Journal für Chemie und Physik, vi. 60.

[||] *Buchner's* Repertorium für die Pharmacie, xxi. 1.

[¶] Philosophical Transactions, 1831, cxxi. 147.

The galvanic action now goes on, and metallic arsenic is very slowly formed on the platinum wire, or subsides in the fluid around it. In weak solutions several days are required to complete the action. With a small voltaic pile or galvanic trough, the positive pole of which is immersed in the external fluid, and the negative pole in the arsenical solution, the action takes place more briskly. This elegant mode of separating the metal is unfortunately not delicate. *Fischer* says he could detect a 60th of a grain of oxide of arsenic by a battery of fifty one-inch plates, and a tenth of a grain by the simple galvanic circle described above. But he was unable to detect it satisfactorily when dissolved in more than 500 times its weight of water. *Buchner* has farther stated that he never could separate by means of galvanism more than from an eighth to a fourth of the arsenic in solution, because part remained in solution, and part escaped in the form of arseniuretted-hydrogen [*]. And *Professor Pleischl* of Prag, in confirming the observations of Buchner, adds, that in an experiment made on a calf expressly for the purpose, he detected arsenic by Rose's method of analysis in the contents of the stomach, but could get no indication of it by Fischer's galvanic test.[†] In the trials I have myself made of this method, it certainly has not appeared to possess the delicacy which some have supposed; and one obvious reason is, that if the process requires many hours or several days for its completion, as often happens when the quantity or proportion of arsenic is small, a considerable part of the fluid in the tube passes through the bladder into the saline solution externally by exosmose,—as might indeed be anticipated from the discoveries of *Dutrochet* [‡] and others on this singular and important phenomenon.

The method of *Mr Davy* is somewhat different. The suspected solution previously acidulated with muriatic acid is placed in a platinum spoon or small platinum crucible, or with a slip of platinum foil in any other vessel; and galvanic action is excited by applying to the fluid a small plate of zinc. In a short time metallic arsenic is deposited on the platinum, from which it may be obtained in the form of oxide by sublimation. This appears from Mr Davy's observations to be both a delicate and characteristic mode of operating. Whether it is free from the objections to which the other galvanic processes are exposed Mr Davy does not state; indeed he has not adverted in his paper at all to the prior researches of Fischer and his countrymen. It would appear to be fully better adapted to discover exceedingly small quantities moderately concentrated, than only small proportions in diluted fluids.

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[*] Repertorium für die Pharmacie, xxi. 21.

[†] *Ibidem*, 443.

[‡] L'agent immediat du mouvement vital, 1826. Nouvelles Recherches sur l'Endosmose, et l'Exosmose, 1828.

Of the Tests for the Oxide of Arsenic when mingled with organic fluids and solids, and particularly with the contents and tissues of the stomach.

The present is by far the most important of the three conditions under which it may be necessary for the medical jurist to search for the presence of arsenic; for in nine cases out of ten the subject of analysis is the stomach with its contents. It is only of late years, however, that this variety of analysis has received particular attention, especially in Britain, and till lately it was enveloped in much difficulty and uncertainty. In the succeeding pages a process will be related, (a modification of one published by me in 1824, and of that described above for the detection of arsenic in mineral fluids,) by which in every instance the poison may be detected with as great certainty, and nearly as great ease, as when it is in a state of pure solution.

If what has been said of the modifications which the liquid tests for arsenic undergo in their action when they are applied to vegetable and animal fluids be reconsidered, it will at once be seen that they are quite useless in relation to such fluids. If the solution, indeed, contains a large proportion of arsenic, and is not deeply coloured, all the three will act in the usual manner. But in actual practice the solutions are almost always diluted; and then the liquid tests, with the exception of sulphuretted-hydrogen gas, either do not act at all, or throw down precipitates so materially altered in tint from those which alone are characteristic of their action, that their employment would lead to frequent mistakes. These statements are the result of an extensive set of experiments which I made some years ago on various articles of food and drink *; and they have since been amply confirmed in every medico-legal case in which I have been engaged. In five judicial cases in which I have had to search for arsenic among the contents and tissues of the stomach, the ammoniacal nitrate of silver and ammoniacal sulphate of copper did not indicate the presence of the poison; but in all of them it was detected unequivocally by a process analogous to that now to be mentioned. In organic fluids, therefore, the liquid reagents must be entirely discarded except as trial tests.

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* Edin. Med. and Surg. Journal, xxii. 60.

The first step of the process for detecting arsenic in organic fluids is to procure a transparent solution. For this end it is sufficient to boil the suspected material for half an hour, distilled water being previously added if necessary, and any solid matters being cut into small pieces. The arsenic is thus entirely taken up, even from the contents and tissues of the stomach: I have proved elsewhere that none is left behind when they are cut into small shreds and well boiled *. The coarser solid particles being then separated by a gauze filter, the fluid is to be filtered through paper. In the case of the contents or tissues of the stomach, the filtration is slow, occupying at least thirty-six hours. If greater dispatch is necessary, it is useful to boil with it a little caustic potass previous to filtering through paper.

The next step is to free the fluid as much as possible from animal matter, in order to procure subsequently a sulphuret which shall not yield empyreuma when reduced; for animal matter in solution is very apt to be thrown down along with the sulphuret; and a small quantity of animal empyreuma will render the reduction precarious.—The removal of animal matter may sometimes be sufficiently accomplished by acetic acid alone, which coagulates some animal principles, such as casein.

In order to ascertain whether after this addition the fluid is ready for the sulphuretted-hydrogen, neutralize it with ammonia or potass, and test a few drops with ammoniacal nitrate of silver as a trial test. If it gives a characteristic precipitate, the oxide is pretty abundant, the fluid is free enough of animal matter, and the process for converting the arsenic into sulphuret may be proceeded with. If the silver test does not act characteristically, another step will be required for removing the animal matter.

For this purpose all that is necessary is to evaporate the solution at a moderate heat to dryness, to form a solution anew

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* Edin. Med. and Surg. Journal, xxii. 76.

by boiling successive portions of distilled water on the residue, and to filter this solution. Another plan by means of nitrate of silver was proposed in the first edition of this work; but although I have found it to answer well, the plan by evaporation to dryness and re-solution is probably preferable, in the hands especially of unpractised persons, as being considerably more simple.

The next steps are the same with those formerly described [246] for detecting the oxide of arsenic in mineral fluids, namely, acidulation with acetic acid, precipitation by sulphuretted-hydrogen, reduction of the sulphuret, and oxidation of the metal. Some precautions, however, must be attended to in following out these steps. In the first place, if the sulphuret after boiling does not subside easily, it is often useful to add a little muriate of ammonia to the fluid *; and, if the fluid still continues muddy, and the deposition not complete, it is right to leave it at rest for forty-eight hours or upwards. By attending to one or other or both of these precautions, it will always be separated sufficiently pure for the subsequent process of reduction. It is particularly essential to allow ample time for the separation and subsidence of the precipitate: *Orfila* has mentioned the particulars of an important criminal case, where two successive analyses by different chemists failed to detect arsenic, but where he succeeded unequivocally by attending to this simple precaution †. Secondly, if, notwithstanding all possible care, the crust is obscure, then the portion of the tube containing it should be cut off, broken in pieces, and heated in a fresh tube.—By operating according to the plan now laid down, I have never failed to procure from the most complex fluids an arsenical crust with its most characteristic properties, and have never experienced in the act of reduction any material inconvenience from empyreuma.

Many other processes have been conceived for detecting arsenic in vegetable and animal fluids. The greater number of them have been examined fully in my paper on the analysis of arsenical fluids in the Edinburgh Medical and Surgical Journal, where will be found a minute account of the reasons for prefer-ring to them the process adopted in this work. It is unnecessary, therefore, to do more in the present place than to notice them succinctly.

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* Buchner's Toxikologie, 430. Ed. 1827.

† Annales d'Hyg. Publique et de Méd. Légale.

Professor Orfila proposed to decolorize the suspected solutions with chlorine, under the expectation that the liquid tests would then act characteristically [*]. I am not aware whether he has ever seen the objections stated in my paper against this process; but he seems now satisfied of its inadequacy, as it is not reprinted in the last edition of his Toxicology, or Médecine-Légale.

Mr Phillips proposed to effect the same end by digesting the arsenical fluid with animal charcoal [†]. In my paper, and in an exchange of criticisms subsequently published by Mr Phillips and myself in the Annals of Philosophy, the reader will find the means of judging for himself as to the value of this process. It is certainly much superior to that of Orfila, and also better than, from misunderstanding one of the author's directions, I was at first led to conceive. But my objections still stand good, and are modified by Mr Phillips's defence in degree merely. No one besides will now-a-days think of adopting the process by liquid reagents in preference to that by reduction, when the latter has been rendered equally delicate with the former.

Rose of Berlin proposed some time ago the process which is still generally adopted in Germany,—consisting in the formation of an arsenite of lime, and its subsequent reduction with charcoal and boracic acid [‡]. In my paper will be found some remarks on his process, which on the whole is a good one, though not equal to that by sulphuretted-hydrogen.

Another process, of which *Rapp*, likewise a German chemist, was the proposer, and which was adopted till lately by Orfila, consists in deflagrating the organic matter, and peroxidating at the same time the oxide of arsenic by means of fused nitrate of potass [§]. This process, as will be seen from my paper already quoted, is inferior in certainty to that of Rose.

Dr Paris has proposed to throw down the whole arsenic by the ammoniacal nitrate of silver, and to reduce the precipitate in a tube [‖]. To this proposal two weighty objections exist.

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[*] Leçons de Médecine-Légale, ii. 93.

[†] Annals of Philosophy, N. S. vii. 31.

[‡] *Gehlen's* Journal für Chemie und Physik, ii. 665.

[§] Diss. Inaug. circa Methodos veneficium arsenicale detegendi, Tubingæ, 1817.

[‖] Medical Jurisprudence, ii. 253.

The arsenite of silver often remains in solution; and it is thrown down along with so much vegetable or animal matter, that the reduction of the precipitate is very precarious.

The next process to be mentioned is by far the best of those now under consideration, but it has no advantage in point of delicacy or certainty over that which I have adopted, and is much more complicated. It was proposed by Berzelius in his *Arsberättelse* for 1825, as a modification and improvement upon the one published by me in 1824; to which, as formerly observed, he objects that the sulphuret is not all decomposed during the reduction. The suspected substance is boiled in potass, and the solution is then neutralized with hydrochloric acid, treated with a stream of sulphuretted-hydrogen, boiled and evaporated till the precipitate subsides. The precipitate is then collected, dried, mixed with nitre in large proportion, and deflagrated in a tube. The product is next dissolved in an excess of lime water, and the arseniate of lime so formed is collected and reduced with charcoal. The inconveniences of this process are the following. The whole sulphuret is not always separated from the solution, because animal matter, as formerly noticed, possesses a solvent or suspending power over it:—The deflagration of the sulphuret, although, as Berzelius mentions, it takes place without flame when the proportion of nitre is large, I have found to be a precarious operation in the hands of the unpractised, who should never be lost sight of, at least in Britain, where nineteen-twentieths of medico-legal analyzers are of this description:—the arseniate of lime is partly retained in solution and washed off the filter; for it is by no means insoluble:—As formerly mentioned, the whole of the arsenic in the arseniate of lime is not sublimed, but only about one-third of it, even with the full red-heat of the blowpipe.

A modification of the process of Berzelius has been lately proposed by *Mr Venables* *. He follows the instructions given in the former edition of this work for separating the arsenic from the liquid in the form of sulphuret nearly free of animal matter. But he then converts the sulphuret into arseniate of potass by deflagration with nitre, dissolves the product, supersaturates the solution with acetic acid, and by means of the nitrate of silver throws down the arseniate of silver, which he subsequently re-

* London Medical Gazette, viii. 806.

duces in a tube with charcoal and boracic acid. The principal advantage of this process is that, according to the author, the arseniate of silver parts with all or nearly all its arsenic by the process of reduction, while the sulphuret parts with little more than a third part. I question much, however, if this advantage is not more than counterbalanced by the great addition to the complexity of the process,—a complexity so great as to render it extremely difficult for any one but an expert chemist to carry through the analysis with success.

Orfila in the last edition of his Toxicology has followed a process which is a modification of the method by sulphuretted-hydrogen. He proposes to destroy the animal matter previous to using the sulphuretted-hydrogen, by boiling the suspected solution with nitric acid, then to neutralize with potass, to add hydrochloric acid in slight excess, to pour in sulphuretted-hydrogen water, to boil and allow the precipitate to subside, to throw it on a filter, and, as it contains an excess of sulphur, to wash the sulphuret through with diluted ammonia, and finally to throw down the sulphuret again with hydrochloric acid. The process stops here, and too soon; for undoubtedly the reduction of the sulphuret ought to be superadded. More recently he has adopted a process in every essential particular the same with that recommended in the former and present editions of this work *.

Mr E. Davy has shown that his galvanic method is applicable to organic fluids as well as simple solutions. I should apprehend, however, that in the instance of some organic fluids, more especially the contents of the stomach, where the proportion of poison is small, it may be inconvenient to concentrate the fluid sufficiently on account of the thick consistence it may assume.

Dr Taufflieb has lately proposed to remove organic matter by means of oxide of zinc. After boiling the suspected matter and obtaining a mucilaginous fluid by filtration, this is to be treated with a solution of oxide of zinc in caustic potassa. Much organic matter separates in combination with the metallic oxide and is removed by filtration. The fluid being then supersaturated by muriatic acid, sulphuretted-hydrogen is transmitted; the sulphuret of zinc is kept dissolved by the muriatic acid, and sulphuret of arsenic is thrown down pure enough to be reduced in the ordinary way. Some peculiarities of manipulation are added for reducing the sulphuret, which do not appear important[*].

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* Cours de Médecine-Légale, 3ème Edition, 1832. iii. 157.

In regard to the process which has been recommended above, it will of course be concluded that I consider it equal to all and preferable to most of those now enumerated. It is simple:—I am persuaded that it removes animal matter sufficiently to secure success in the process of reduction,—if the operator take care to proceed very gradually in applying the heat, and to dry the inside of the tube as moisture condenses on it:—The sulphuret will always separate properly, if sufficient time be allowed:—And although the whole arsenic in the sulphuret is not driven off by the process of reduction, a sufficient quantity will be separated from the most minute portion of sulphuret we can collect, to exhibit the characters of the metal or oxide or both characteristically.

3. *Arsenite of Copper.*

The arsenite of copper, [Scheele's-Green, Mineral Green] is another preparation of arsenic, which deserves a little notice, because it is well known and in use as a pigment, and has actually been used as a poison. Dr Duncan Junior once detected it in pills, which were said to have been given to a pregnant female with the view of procuring abortion; and in Paris it has been detected in sweetmeats, having been used to give them a fine green colour[†].

It is a compound of arsenious acid and deutoxide of copper, is sold in powder or pulverulent cakes, and has a fine grass-green colour. Its nature may be ascertained by the process of reduction in a glass tube. Being mixed with a little charcoal and heated in the tube, metallic arsenic sublimes, and the copper remains. The existence of the copper is proved by acting with diluted nitric acid on the residue after the action of heat, and then filtering and supersaturating with ammonia,—upon which a fine violet-blue solution will be formed. If Mineral-green is heated in a tube without charcoal, a white crystalline sublimate is raised, which is oxide of arsenic.

We must not always expect to find arsenic in the Mineral-Green of the shops. The colour sold in the shops of Edinburgh under that name, although it is believed by colour-men to be a preparation of arsenic, is not the arsenite of copper or mineral-green of Scheele, but, as I have often ascertained by analysis, a mixture of the hydrated oxide of copper and carbonate of lime; which will be mentioned more particularly under the head of the poisons of copper.

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[*] Journal de Pharmacie, xx. 392.

[†] Revue Médicale, 1827, i. 365.

Process for Organic Mixtures.—The process for detecting arsenite of copper in organic mixtures is simple. The suspected mixture is to be heated with a little acetic acid and well stirred. The arsenite being thus dissolved, the solution is to be allowed to cool and then filtered. A stream of sulphuretted-hydrogen will now cause a dark-brown or yellowish-brown muddiness or precipitate, which is a mixture of sulphuret of copper and sulphuret of arsenic. The precipitate being separated after boiling, and properly cleansed by the process of subsidence and affusion, or, if it is large, by washing on a filter, the two sulphurets are to be separated by ammonia, which dissolves sulphuret of arsenic but leaves the sulphuret of copper; and the sulphuret of arsenic may then be recovered by supersaturation with muriatic acid. The sulphuret of arsenic is next to be reduced in the manner formerly directed; and the sulphuret of copper examined as recommended under the head of copper.

4. *Arsenite of Potass.*

This salt is an object of some importance to the medical jurist, as it forms the basis of a common medicine, *Fowler's Solution*, or the *Tasteless Ague Drop*. It has a brownish-red colour and smells of lavender. It contains in every ounce four grains of arsenious acid.

The best method of ascertaining its nature is to subject it to the process for the detection of arsenic in mixed fluids. It will be sufficient, however, to acidulate it at once with acetic acid, and then to transmit the sulphuretted-hydrogen gas.

5. *Arseniate of Potass.*

This substance is so rarely met with as to be an object of very little consequence to the medical jurist: Nevertheless I have found in the course of reading two instances of poisoning with it. A very dangerous and tedious case has been related by *Professor Bernt*, which arose from too great a quantity having been given medicinally by an ignorant druggist *; and a case of accidental poisoning with it has been related in the London Medical Repository [*]. It is the preparation of arsenic which was till lately preferred by the Dublin College of Physicians in their Pharmacopœia. A singular account has been published of the accidental poisoning of seven horses with it at Paris. They all died, most of them with the symptoms and morbid appearances of well-marked inflammation of the alimentary canal [†].

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* Beiträge zur gerichtlichen Arzneikunde, iv. 221.

When solid it forms tetraedral prismatic crystals, acuminated by four planes. It is very soluble in water, fuses at a red heat, and on cooling concretes into a crumbly, foliaceous mass, having a pearly lustre. It is easily known by the effect of the process of reduction—of the nitrate of silver, the salts of copper, and sulphuretted-hydrogen. Heated with charcoal in a tube it gives off metallic arsenic in the usual manner; but a stronger heat is required than for the reduction of the arsenious acid. Dissolved in water and treated with nitrate of silver it yields a brick-red precipitate, the arseniate of silver. With the salts of copper its solution gives a pale bluish-white precipitate, the arseniate of copper. With sulphuretted-hydrogen gas, preceded by acidulation with muriatic acid, and transmitted for a considerable length of time, it yields the yellow sulphuret of arsenic.

6. *The Sulphurets of Arsenic.*

In the arts various substances are known which contain a compound of sulphur and arsenic. In the first place, two pure sulphurets are known in chemistry and in painting, the one of a fine orange colour, and known by the name of Realgar, the other of a rich sulphur yellow, and termed Orpiment. Secondly, the name of Orpiment is familiarly given to a pigment in more general use than either of the former, which has a less lively colour, and consists of pure orpiment with a large admixture of arsenious acid. Lastly, orpiment also forms a great proportion of another common pigment, King's Yellow.

The orange red sulphuret, (Realgar, Risigallum, Σανδαραχη, Sandaracha,) is chiefly a natural production. It is solid, of a bright orange-red colour, and composed of small shining scales, which may be scratched with the nail. It is composed of thirty-eight parts of metal and sixteen of sulphur. Its best chemical characters are the disengagement of metallic arsenic when it is heated in a tube with potass or the black flux; and its undergoing sublimation unchanged when heated alone in a tube.

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[*] January 1819.

[†] Annales d'Hygiène Publ. et de Méd. Légale, xii. 393.

The yellow sulphuret, (Orpiment, auripigmentum, αρσενικον,) is both a natural production, and the result of many chemical operations. The sulphuret thrown down from solutions of arsenic by sulphuretted-hydrogen is quite conformable in physical and chemical characters with the natural orpiment. Natural orpiment, when in mass, consists of broad scales of much brilliancy and of a rich yellow colour. It is composed of thirty-eight parts of metal and twenty-four of sulphur. Its most striking chemical characters are the same with those of realgar, from which it is distinguished chiefly by its colour.

It has been stated by *Hahnemann* in his elaborate work on Arsenic, that the pure sulphurets are somewhat soluble in water,—that the native orpiment is soluble in 5000 parts of water with the aid of ebullition, and that the artificial orpiment by precipitation is soluble in 600 parts of water *. Hahnemann, however, was mistaken in supposing that the water dissolved these sulphurets. It does not dissolve, but decomposes them. Very lately *M. Decourdemanche* has found that, by slow action in cold water, and much more quickly with the aid of heat, the arsenical sulphuret is decomposed by virtue of a simultaneous decomposition of the water, sulphuretted-hydrogen being evolved and an oxide of arsenic remaining in solution. And he has farther remarked, that this change is promoted by the presence of animal and vegetable principles dissolved in the water †. These facts are interesting, as they explain certain apparent anomalies to be noticed presently in the physiological properties of the sulphurets.

The common orpiment of the shops is not a pure sulphuret like the natural orpiment, but a much more active substance, a mixture of orpiment and arsenious acid. It is made by subliming in close vessels a mixture of sulphur and common arsenic. It is met with in the shops in two forms, in that of a fine powder possessing a yellow colour with a faint tint of orange, and in that of concave masses composed of layers of various tints of white, yellow, and orange, commonly also lined internally with tetraedral white pyramidal crystals. Till lately it was accounted a variety of sulphuret, and some ingenious conjectures were made as to the cause of its superior energy over the other sulphurets as a poison. But *M. Guibourt* has recently proved that it always contains oxide of arsenic, and is commonly impregnated with it to a very large amount, some parcels containing so much as 96 per cent. * The inner surface I have often seen lined with large crystals of pure oxide. In a very interesting account lately published by *Dr Symonds* of Bristol, describing the case of Mrs Smith, for whose murder a woman Burdock was executed in that city a few months ago, it is stated as proved at the trial that artificial orpiment was the poison given, that death took place in a very few hours, and that a sample from the druggist's shop where the poison was bought contained on an average 79 per cent. of oxide of arsenic †.

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* Uber die Arsenic-vergiftung, pp. 14, 45.

† Journal de Pharmacie, xiii. 207.

Another impure sulphuret, a good deal used in painting, and a favourite poison in this country for killing flies, is King's Yellow. It is sold in the form of a light powder or in loose conical cakes. It has an intense sulphur-yellow colour. This substance is soluble, though not entirely, in water, both cold and warm, and forms a colourless solution, from which, on cooling, or by evaporation, a yellow powder separates. In this respect it differs essentially from the pure sulphurets. The solution is not acted on by reagents in the same way as the solution of arsenious acid. Lime-water and sulphuretted-hydrogen have no effect on it, the ammoniacal nitrate of silver causes a copious dirty brown, and the ammoniacal sulphate of copper a scanty, dirty lemon-yellow precipitate. I have not seen any account of the mode of preparing it or an analysis of its composition. But according to my own experiments it contains a large proportion of sulphuret of arsenic, a considerable proportion of lime, and about 16 per cent. of sulphur. Its nature is best shown by the following method of analysis. Let the powder be agitated in diluted ammonia till the colour becomes white. The filtered fluid contains the sulphuret of arsenic, which, on the addition of an acid, falls down, and may be separated and reduced in a tube with the black flux. The remaining white powder, well freed from adhering sulphuret by washing, is next to be agitated in diluted acetic or hydrochloric acid and again filtered. The solution on being neutralized precipitates abundantly with oxalate of ammonia and the alkaline carbonates, showing that lime was taken up by the acid: and, as the acid operates without effervescence, the lime must have been in the caustic state. The powder which remains after the action of the acid will be found to fuse with a gentle heat and to burn almost entirely away with a blue flame, emitting sulphureous vapours. These experiments make it obvious that King's yellow contains sulphuret of arsenic, caustic lime, and free sulphur; and in all probability the lime exists in the form of a triple sulphuret of lime and arsenic.

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* Journal de Chim. Méd. ii. 113.

† Trans. of Provincial Med. and Surg. Association, iii. 465.

All the preparations containing the sulphuret of arsenic are interesting to the medical jurist, but particularly the two impure sulphurets last mentioned. The King's yellow above all should be carefully studied, because on account of its frequent employment as a fly-poison it has been often the source of fatal accidents. It was likewise taken intentionally a few years ago in this city, and proved fatal in thirty-six hours. *Dr Duncan* also, while he was Professor of Medical Jurisprudence, met with an instance of an attempt to poison by mixing King's yellow with tea; and at the Glasgow Spring Circuit of 1822 a woman was tried for poisoning her child with it.

Process for Organic Mixtures.—If sulphuret of arsenic be present in such mixtures in appreciable quantity, the particles, owing to their intense yellow colour, will be visible in any mass which has not the same tint. From this state of admixture they may be removed by adding caustic ammonia which dissolves sulphuret of arsenic; and the solution, on being acidulated with muriatic acid, will deposit the sulphuret sufficiently pure for undergoing the process of reduction.

Sulphuret of arsenic sometimes exists in small quantity in the stomach, although the poison was given in the form of oxide; for a portion of the oxide is subject to be converted into the sulphuret by the sulphuretted-hydrogen gas evolved in the stomach after death. This phenomenon, which I believe was first distinctly noticed by myself, has since been observed repeatedly *. In every instance yet carefully examined a large proportion of the oxide has remained unacted on, although the intense colour of the mixed sulphuret makes it appear as if that were the only compound present.

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* See subsequently *Morbid Appearances*.

SECTION II.—*Of the Action of Arsenic and the Symptoms it excites in Man.*

It seems pretty evident, and is indeed generally admitted by those who have turned their attention to the subject, that arsenic produces in the living body two classes of phenomena,—or that, like the narcotico-acrids, it has a twofold action. One action is purely irritant, by virtue of which it induces inflammation in the alimentary canal and elsewhere. The other, although it seldom occasions symptoms of narcotism properly so called, yet obviously consists in a disorder of parts or organs remote from the seat of its application.

It is also the general opinion of toxicologists, that arsenic occasions death more frequently through means of its remote effects than in consequence of the local inflammation it excites. In some cases indeed no symptoms of inflammation occur at all; and in many others, although inflammation is obviously produced, death takes place long before it has had time to cause material organic injury. Nevertheless in some, though certainly in comparatively few instances, the local action, it must be admitted, predominates so much, that the morbid changes of the part primarily acted on are alone adequate to account for death.

Its chief operation being on organs remote from the part to which it is applied, a natural object of inquiry is, whether this action results from the poison entering the blood, and so passing to the remote organs acted on, or simply arises from the organ remotely affected sympathizing through the medium of the nerves with the impression made on the organ which is affected primarily. On this question precise experiments are still wanted. The general opinion seems to be that it acts through the blood. Dr Addison and Mr Morgan will, I presume, say, that if it must enter the blood before it acts, this is only because it operates by an impression made on the nervous expansion of the inner coat of the vessels, and the conveyance of that impression along the nerves. At all events, however, it is generally believed that arsenic does enter the blood. Yet no one has hitherto been able to discover it satisfactorily there. It is said, indeed, to have been lately discovered in the course of a few imperfect experiments instituted for the purpose by *Foderé:* In persons using arsenic medicinally, he twice got indications of its presence in the urine; nitrate of silver, and sulphuretted-hydrogen, each producing a pale yellowish-white cloud [*]. But the observations formerly made on the fallacies to which these tests are exposed render his results quite inconclusive.—An observation made by *Professor Marx* in his elaborate work on Poisons, would countenance the idea that *Emmert* had found arsenic in some of the soft solids of the body; for he observes on the authority of the experiments of that toxicologist, that "of the various parts of animals poisoned with arsenic the spinal chord is alone fatal to other animals, and injected *poison*, which cannot be found even in the blood-vessels, was detected in the posterior part of the brain and in the spinal chord [†]." But I have been unable to find any passage in the papers of Emmert which warrant this statement.—In cats poisoned, some of them slowly, others quickly, with arsenic, *Dr Hardegg* could find no arsenic by any of its fluid tests in the blood, brain, or spinal chord [‡].—In a horse which took eleven drachms and a half of arsenic in sixty hours and died thirty-six hours after the last dose, *Dr Schubarth* could not detect any of the poison by Rose's process in the liver, lungs, muscles, heart, kidneys, spleen, blood or brain [§]. The want of conclusive facts to prove the presence of arsenic throughout the body need not excite any surprise, considering the minute quantity in which poisons operate, and the difficulty of detecting such quantities in the blood, (p. 15.)

Our knowledge of the nature of the remote action of arsenic is in some respects as vague as our information regarding the channel through which it is established. Toxicologists have for the most part been satisfied with calling it a disorder of the general nervous system. When employed to designate the state of collapse which accompanies or forms the chief feature of the acute cases of poisoning with arsenic, this term is misapplied. The whole train of symptoms is that not of a general nervous disorder, but simply of depressed action of the heart. That this is the chief organ remotely acted on in such cases farther appears probable from certain physiological experiments, in which it has been remarked, that immediately after rapid death from arsenic the irritability of the heart was exhausted or nearly so, while that of the intestines, gullet, and voluntary muscles continued as usual[*]. As to the singular symptoms which often arise in the advanced stage of lingering cases, the term disorder of the general nervous system is more appropriately applied to them. They clearly indicate a deranged state sometimes of the brain, sometimes of particular nerves.

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[*] Journal Complémentaire, i. 118, 128.

[†] *Marx*. Die Lehre von den Giften, I. ii. 44.

[‡] Diss. Inaug. de vario arsenici in animalia effectu. Tubingæ, 1817, quoted by Marx. I. ii. 184.

[§] Beiträge zur näheren Kentniss, &c. in *Horn's* Archiv für Medizinische Erfahrung, 1823, ii. 407.

Arsenic belongs to those poisons which act with nearly the same energy whatever be the organ or texture to which they are applied. The experiments of *Sproegel*[†], which have been repeated by *Jaeger*[‡], and more recently by *Mr Brodie*[§], leave no doubt, that when applied to a fresh wound it acts with at least equal rapidity as when swallowed. Although in such circumstances the signs of irritation are often distinct, yet the symptoms are on the other hand sometimes more purely narcotic than by any other mode of administering it,—Mr Brodie in particular having observed loss of sense and motion to be induced, along with occasional convulsions. Arsenic likewise acts with energy when applied to the conjunctiva of the eye, as was proved by *Dr Campbell.* It farther acts with violence through the mucous membrane of the vagina, producing local inflammation, and the usual constitutional collapse. These facts were determined experimentally by the Medical Inspectors of Copenhagen on the occasion of a singular trial which will be noticed afterwards. Arsenic also acts, as may easily be conceived, when injected into the rectum. And farther, it acts as a poison, when it is applied to the surface of ulcers, yet certainly not under all circumstances. Its power of acting through the unbroken skin has been questioned. *Jaeger* found that, when it was merely applied and not rubbed on the skin of animals, it had no effect[||]. But some cases will be afterwards mentioned which tend to show that the reverse probably holds in regard to man. According to the last-mentioned author, who is the only experimentalist that has hitherto examined the subject consecutively, arsenic is most active when injected into a vein, or applied to a fresh wound, or introduced into the sac of the peritonæum; it is less powerful when taken into the stomach; it is still less energetic when introduced into the rectum; and it is quite inert when applied to the nerves.

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[*] In a rabbit killed by arsenic applied to a wound *Mr Brodie* found the heart contracting feebly after death; and in a dog there were tremulous contractions incapable of supporting circulation. *Sproegel* found the peristaltic motion of the intestines and gullet vigorous in a dog an hour after death. [*Diss. Inaug. in Halleri Disput. Med. Pract.* vi. *Exp.* 31.] *Orfila* in some experiments found the heart apparently inflamed and its irritability destroyed. [Arch. Gén. de Méd. i. 147.]

[†] Haller's Disput. Med. Pract. vi. Exp. 35.

[‡] Diss. Inaug. Tubingæ, 1808. De effectibus Arsenici in var. organismos.

[§] Phil. Trans. cii. 211.

[||] Jaeger, p. 28.

It is a striking fact in the action of this poison that, whatever be the texture in the body to which it is applied, provided death do not ensue quickly, it almost always produces symptoms of inflammation in the stomach; and on inspection after death traces of inflammation are found in that organ. In some instances of death caused by its outward application, the inflamed appearance of the stomach has been greater than in many cases where it had been swallowed. *Sproegel* met with a good example of this in a dog killed by a drachm applied to wounds. The whole stomach and intestines, outwardly and inwardly, were of a deep-red colour, blood was extravasated between the membranes, and clots were even found in the stomach *.

Of the different preparations of arsenic, it may be said in general terms, that those are most active which are most soluble. In conformity with what appears to be a general law in toxicology, the metal itself is inert. It is difficult to put this fairly to the test, because it is not easy to pulverize the metal without a sufficient quantity being oxidated to cause poisonous effects. *Bayen* and *Deyeux*, however, found, that a drachm carefully prepared might be given in fragments to dogs without injuring them; and they once gave a cat half an ounce without any other consequence than temporary loss of flesh †. Its alloys are also inert. The same experimentalists found it inactive when combined with tin; and *Renault* also found it inactive when united with sulphur and iron in the ore mispickel, or arsenical pyrites ‡.

It is probable that all the other preparations of arsenic are more or less deleterious.

A difference of opinion prevails as to the power of the sulphurets. Various statements have been published on the subject. But it may be sufficient to observe, that in consequence of *M. Guibourt* having lately denied the poisonous properties of the sulphurets, and imputed their apparently deleterious effects to the admixture of the oxide, with which, as formerly stated, he found them often adulterated [*], — *Professor Orfila* made some experiments on dogs with the native orpiment and realgar, and with the sulphuret procured by sulphuretted-hydrogen gas, (which are all pure sulphurets); and he found that in doses varying from 40 to 70 grains they all caused death in two, three, or six days, whether they were applied to a wound, or introduced into the stomach [†]. It may appear at first view singular that the sulphurets, which contain arsenic in its metallic state, should be poisonous, while metallic arsenic itself is inert; but the apparent anomaly vanishes on considering the experiments of *M. Decourdemanche* formerly noticed: which prove that in animal fluids the sulphurets are rapidly changed into the oxide, (see p. 267.) The sulphurets, although certainly poisonous, are much less active than the preparations in which the metal exists already oxidated. Yet in sufficient doses they will prove rapidly fatal. In the *Acta Germanica* there is the case of a woman who was killed in a few hours by realgar, mixed by her step-daughter in red-cabbage soup [‡]. The common artificial orpiment procured by sublimation is very active, in consequence of the oxide mixed with it. *Renault* found three grains killed a dog in nine hours [§].

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* Halleri Disput., &c. Exp. 36.

† *Renault* sur les Contrepoisons de l'Arsenic, p. 42.

‡ Ibidem, 45.

Among the less active preparations of arsenic may also be enumerated such of the arsenites and arseniates as are not soluble in water. They have not indeed been actually tried. But there can be little doubt that they will prove poisonous; because, though insoluble in water, they are probably somewhat soluble in the animal juices. We may infer from their sparing solubility, even in these menstrua, that they will be less active than the preparations now to be mentioned, which are more soluble.

These are the alkaline arsenites and arseniates, arsenic acid, arsenious acid, the black oxide or fly-powder, and arseniuret-ed-hydrogen. With regard to arsenic acid, and the alkaline arseniates and arsenites, it is probable, from their effects in medicinal doses, that they are as active as the white oxide, if not more so. But they have not been particularly examined, as they are not objects of great interest to the medical jurist.

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[*] Journal de Chim. Méd. ii. 113.

[†] Ibidem, 153.

[‡] Acta Germanica, v. Observ. 102.

[§] Sur les Contrepoisons de l'Arsenic, p. 57.

The fly-powder or black oxide is very active. Renault found that four grains killed a middle-sized dog in ten hours [*]. It has been likewise known to prove quickly fatal to man. In a recent French journal there is a case which ended fatally in sixteen hours [†]; and in the Acta Germanica is an account of four persons, who died in consequence of eating a dish of stewed pears poisoned with it, and of whom three died within eighteen hours [‡]. The dose is not mentioned; but it is probable from the collateral circumstances that it was not considerable.

Arseniuretted-hydrogen, though probably the most active of all the arsenical compounds, need not be dwelt on particularly on account of its extreme rarity. It is well known that the celebrated German chemist *Gehlen* died from accidentally inhaling a small portion of it: and that in consequence of this accident few chemists venture to prepare it. Gehlen died in nine days with the usual symptoms of arsenical poisoning [§].

It is of some consequence to settle with precision the power of the white oxide. Witnesses are very often asked on trials how small a quantity will occasion death? It is obvious that this question admits only of a vague answer: It can be answered at all only in reference to concomitant circumstances, and even then but presumptively. Nevertheless, it is right to be aware what facts are known on the subject.

It has been stated by various authors that the white oxide will prove fatal to man in the dose of two grains. *Hahnemann* says in more special terms, that in circumstances favourable to its action four grains may cause death within twenty-four hours, and that even one or two grains may prove fatal in a few days [||]. But neither he nor any of the other authors alluded to have referred to actual cases. *Foderé* knew half a grain cause colic pains in the stomach and dysenteric flux, which continued obstinately for eight days [*]; and I have related an instance where six persons, after taking each a grain in wine during dinner, were seriously and violently affected for twelve hours [†]. The smallest actually fatal dose I have hitherto found recorded is 4½ grains. The subject was a child four years old, and death occurred in six hours [‡]. In this instance, however, the poison was taken in solution. *Alberti* mentions the case of a man who died from taking six grains; but I am unacquainted with the particulars, not having seen the original account [§]. The next smallest fatal dose of solid arsenic I have yet read of is thirty grains. The subject an adult died in six days [||]. Although death took place in this instance slowly, we can hardly doubt that a much less dose would prove fatal. The effects of medicinal doses, which seldom exceed a quarter of a grain without causing irritation of the stomach, and the fatal effects of somewhat larger doses on animals, *Renault* having found that a single grain in solution killed a large dog in four hours [¶], must convince every one that the general statement of Hahnemann cannot be very wide of the truth.

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[*] Sur les Contrepoisons de l'Arsenic, p. 48.

[†] Nouv. Bibliothèque Méd. 1827, ii. 59.

[‡] Acta Germanica, v. Observ. 102.

[§] Buchner's Toxikologie, 476.

[||] Ueber Arsenic-Vergiftung, p. 53-4.

It is not improbable that the activity of oxide of arsenic is impaired by admixture with other insoluble powders. *M. Bertrand*, conceiving from some experiments on animals that he had found an antidote for arsenic in charcoal powder, took no less than five grains of the oxide mixed with that substance, and he did not suffer any injury, although his stomach was empty at the time, and he did not vomit [**]. But *Orfila* afterwards showed, that other insoluble powders, such as clay, have the same effect; that no such powder can be of any use if not introduced into the stomach till after the arsenic is swallowed; and that they appear to act solely by enveloping the arsenical powder and preventing it from touching the membrane of the alimentary canal [††]. Although Mr Bertrand's discovery will not supply the physician with an antidote, the medical jurist will not lose sight of the interesting fact, that, by certain mechanical admixtures, arsenic in moderate doses may be entirely deprived of its poisonous quality. A singular case of recovery from no less a dose than sixty grains, which happened in the case of an American physician, probably comes under the same head with the experiments of Bertrand,—a large quantity of powder of cinchona-bark having been swallowed along with the arsenic. In this case, however, the symptoms were severe for three days *.

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[*] Journal Complémentaire, i. 107.

[†] Edin. Med. and Surg. Journal, xxxiii. 67.

[‡] Rust's Magazin für die gesammte Heilkunde, xx. 492.

[§] *Wibmer.* Die Wirkung der Arzneimittel und Gifte, i. 257. From Alberti. Jurispr. Med. v. 619. cas. 24.

[||] Valentini Pandectæ Med. legales, l. iii. c. 24.

[¶] Sur les Contrepoisons de l'Arsenic, p. 62.

[**] *Foderé*, in Journal Complémentaire, i. 107, from *Bertrand*, Manuel Medico-légal des poisons, p. 185.

[††] Toxicologie Générale, i. 429.

The tendency of habit to modify the action of arsenic is questionable. So far as authentic facts go, habit has no power of familiarizing the constitution to its use. One no doubt may hear now and then of mountebanks who swallow without injury entire scruples or drachms of arsenic, and vague accounts have reached me of patients who took unusually large doses for medicinal purposes. But as to facts of the former kind, it is clear that no importance can be attached to them, as it is impossible to know how much of the feat is genuine, and how much legerdemain; and with respect to the latter, I have never been able to ascertain any precise fact of the kind. So far as my own experience goes, the habit of taking arsenic in medicinal doses has quite an opposite effect from familiarizing the stomach to it; and the same observation has been made by many practitioners whom I have consulted.

In the following detail of the symptoms caused by arsenic in man, its effects when swallowed will be first noticed; and then some remarks will be added on the phenomena observed when it is introduced through other channels.

The symptoms of poisoning with arsenic may be advantageously considered under three heads. In one set of cases there are signs of violent irritation of the alimentary canal and sometimes of the other mucous membranes also, accompanied with excessive general depression, but not with distinct disorder of the nervous system. When such cases prove fatal, which they generally do, they terminate for the most part in from twenty-four hours to three days. In a second and very singular set of cases there is little sign of irritation in any part of the ali-

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* American Journal of Med. Science, xi. 61.

mentary canal; perhaps trivial vomiting or slight pain in the stomach, sometimes neither; the patient is chiefly or solely affected with excessive prostration of strength and frequent fainting; and death is seldom delayed beyond the fifth or sixth hour. In a third set of cases life is commonly prolonged at least six days, sometimes much longer, or recovery may even take place after a tedious illness; and the signs of inflammation in the alimentary canal are succeeded or become accompanied about the second or fourth day or later by symptoms of irritation in the other mucous passages, and more particularly by symptoms indicating a derangement of the nervous system, such as palsy or epilepsy. The distinctions now laid down will be found in practice to be well defined, and useful for estimating in criminal cases the weight of the evidence from symptoms.

1. In one order of cases, then, arsenic produces symptoms of irritation or inflammation along the course of the alimentary canal. Such cases are the most frequent of all. The person commonly survives twenty-four hours, seldom more than three days; but instances of the kind have sometimes proved fatal in a few hours, and others have lasted for weeks. On the whole, however, if the case is much shorter than twenty-four hours, or longer than three days, its complexion is altered. In the mildest examples of the present variety recovery takes place after a few attacks of vomiting, and slight general indisposition for a day or two.

In regard to the ordinary progress of the symptoms, the first of a decisive character are sickness and faintness. It is generally thought indeed that the first symptom is an acrid taste; but this notion has been already shown to be erroneous. For some account of the sensations felt in the act of swallowing the poison, the reader may refer to what has been stated in p. 232. There is no doubt, that in the way in which arsenic is usually given with a criminal intent, namely mixed with articles of food, it seldom makes any impression at all upon the senses during the act of swallowing. It has been already said that the records of medical jurisprudence do not contain a satisfactory instance of any person having felt in swallowing that burning sensation in the throat or mouth, which is so generally supposed to be produced by this poison.

In some instances the sickness and faintness, particularly when the poison was taken in solution, have begun a few minutes after it was swallowed. Thus in a case mentioned by *Bernt*, in which a solution of arseniate of potass was taken, the symptoms began violently in fifteen minutes[*]; in another related by *Wildberg*, where the oxide was given in coffee, the person was affected immediately on taking the second cup[†]; in another related by *Mr Edwards* the patient was taken ill in eight minutes[‡]; nay, in a case of poisoning with orpiment in soup mentioned by *Valentini*, the man felt unwell before he had finished his soup, and set it aside as disagreeable[§]. In a case which not long ago came under my notice judicially, the symptoms began in twenty minutes. It is a mistake therefore to suppose, as I have known some do, that arsenic never begins to operate for at least half an hour. Nevertheless it must be admitted, that in general arsenic does not act for half an hour after it is swallowed.—On the other hand, its operation is seldom delayed beyond an hour. The following indeed are the only exceptions to this rule I have hitherto met with. *Mr Macaulay* of Leicester has communicated to me a case where the individual took the poison at eight in the evening, went to bed at half-past nine, and slept till eleven, when he awoke with slight pain in the stomach, vomiting, and cold sweats. In this instance the dose was seven drachms, and death took place in nine hours. *M. Devergie* has related a similar case of poisoning with the sulphuret, where the symptoms did not begin for three hours; and here too the patient fell asleep immediately after swallowing the poison[‖]. *Professor Orfila* has noticed an instance, to be quoted afterwards, where there appears to have been scarcely any symptom at all for five hours[¶] (p. 288). I suspect we must also consider as an instance of the same kind the case of the girl Warden, which gave occasion to the trial of Mrs Smith here in 1827. A white draught was administered in a suspicious manner at ten in the evening; the girl immediately went to bed; and no symptom appeared till six next morning, from which time her illness went on uninterruptedly[*]. In three of the preceding cases it will be remarked that sleep intervened between the taking of the poison and the invasion of the symptoms; and it is therefore not improbable that the reason of the retardation is the comparative inactivity of the animal system during sleep.—In voluntary poisoning, as in a case related by *Dr Roget*, a slight attack of sickness or vomiting occasionally ensues immediately after solid arsenic is swallowed, and some time before the symptoms commence regularly[†].

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[*] Beiträge zur gerichtlichen Arzneikunde, iv. 221.

[†] Praktisches Handbuch für Physiker, iii. 298.

[‡] London Med. and Phys. Journal, xlix. 117.

[§] Pandectæ Medico-legales, P. i. s. iii. cas. xxvi. p. 134, 135.

[‖] Dictionnaire de Méd. et de Chir. Pratiques, Art. Arsenic, iii. 340.

[¶] Archives Générales de Médecine, vii. 14.—Another case somewhat analogous has been related by *Tonnelier* in Corvisart's Journal de Médecine (iv. 15). The person, a girl nineteen years of age, took the poison at eleven, dined pretty heartily at two, and concealed her sufferings till seven. Even before dinner, however, she had been observed occasionally to change countenance, as if uneasy.

The observations now made will often prove important for deciding accusations of poisoning; for pointed evidence may be derived from the commencement of the symptoms after a suspected meal, corresponding or not corresponding with the interval which is known to elapse in ascertained cases. The reader will see the effect of such evidence in attaching guilt to the prisoner in the case of Margaret Wishart, which I have detailed elsewhere[‡]. In the trial of Mrs Smith, the want of the correspondence just mentioned contributed greatly to her acquittal, for the symptoms of poisoning did not begin till more than eight hours after the only occasion on which the prisoner was proved to have administered any thing in a suspicious manner. As I was not at the time acquainted with any parallel case except that recorded by Orfila, I hesitated to ascribe the symptoms to the draught; and consequently, as the other medical witnesses felt the same hesitation on the same account, the proof of administration was considered to have failed. I am not sure that I should have now felt the same difficulty. The intervening state of sleep probably affords an explanation of the long interval; and the cases noticed by Mr Macaulay and M. Devergie are parallel, though the interval in them was certainly not so great.

Soon after the sickness begins, or about the same time, the region of the stomach feels painful, the pain being commonly of a burning kind, and much aggravated by pressure. Violent fits of vomiting and retching then speedily ensue, especially when drink is taken. There is often also a sense of dryness, heat, and tightness in the throat, creating an incessant desire for drink; and this affection of the throat often precedes the vomiting. Occasionally it is altogether wanting, at other times it is so severe as to be attended with fits of suffocation and convulsive vomiting at the sight of fluids [*]. Hoarseness and difficulty of speech are commonly combined with it. The matter vomited, as in other cases of long continued vomiting, is greenish or yellowish; but sometimes it is streaked or mixed with blood, particularly when the case lasts longer than a day.

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[*] Edin. Med. and Surg. Journal, xxvii. 450.

[†] Lond. Med. Chir. Trans. ii. 134.

[‡] Edin. Med. and Surg. Journal, xxix. 23. See also above, p. 79.

In no long time after the first illness diarrhœa generally makes its appearance, but not always. In some cases, instead of it, the patient is tormented by frequent and ineffectual calls: In other cases the great intestines are hardly affected at all. About this time the pain in the pit of the stomach is excruciating, and is often likened by the sufferer to a fire burning with him. It likewise extends more or less throughout the rest of the abdomen, particularly when the diarrhœa or tenesmus is severe; and the belly itself is commonly tense and tender, sometimes also swollen, though not frequently,—sometimes even on the contrary drawn in at the navel [†]. When the diarrhœa is severe, the anus is commonly excoriated and affected with burning pain [‡]. In such cases the burning pain may extend along the whole course of the alimentary canal from the throat to the anus. Nay at times the mouth and lips are also inflamed, presenting dark specks or blisters [§].

Sometimes there are likewise present signs of irritation of the lungs and air-passages,—almost always shortness of breath (which, however, is chiefly owing to the tenderness of the belly,)—often a sense of tightness across the bottom of the chest, and more rarely decided pain in the same quarter, darting also through the upper part of the chest. Sometimes peripneumony has appeared a prominent affection during life, and been distinctly traced in the dead body [||].

In many instances, too, the urinary passages are affected, the patient being harassed with frequent, painful and difficult micturition, swelling of the penis and pain in the region of the bladder, or, if a female, with burning pain of the vagina and excoriation of the labia [*]. Sometimes the irritation of the urinary organs is so great as to be attended with total suppression of urine, as in a case related by *Guilbert* of Montpellier, in which this symptom continued several days [†]. Urinary symptoms are seldom present unless the lower bowels are likewise strongly irritated; but are then seldom altogether wanting. They are rarely well-marked in cases of the present variety, unless life is prolonged three days or more.

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[*] *Wendland* in Augustin's Archiv der Staatsarzneikunde, ii. 34.

[†] Pyl's Aufsätze und Beob., i. 55.

[‡] Bachmann. See subsequently, p. 305. State Trials, xviii. Case of Miss Blandy.

[§] Wepfer, Historia Cicutæ, 276.

[||] In a case by Schlegel. See Henke's Zeitschrift für die Staatsarzneikunde, i. 31.

When the symptoms of irritation of the alimentary canal have subsisted a few hours, convulsive motions often occur in a greater or less degree. They commence on the trunk, afterwards extend over the whole body, are seldom violent, and generally consist of nothing else than tremors and twitches. Another convulsive affection and a very distressing one is cramps of the legs and arms. This symptom may be a concomitant of every kind of diarrhœa; but in that caused by arsenic it is peculiarly severe and frequent.

The general system always sympathizes acutely with the local derangement. The pulse commonly becomes very small, feeble and rapid soon after the vomiting sets in; and in no long time it is often imperceptible. This state of the pulse is naturally attended with great coldness, clammy sweats, and even lividity of the feet and hands. Another symptom referrible to the circulation which has been observed, though very rarely, is palpitation [‡].

The countenance is commonly collapsed from an early period, and almost always expressive of great torture and extreme anxiety; the eyes are red and sparkling, and the conjunctiva often so much injected as to have been considered inflamed [§]; the tongue and mouth parched; and sometimes little white ulcers or aphthæ break out on the velum and palate.

Delirium sometimes accompanies the advanced stage, and stupor also is not unfrequent. Death in general comes on calmly, but is sometimes preceded by a paroxysm of convulsions[*].

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[*] Bachmann, p. 40.

[†] Journal de Médecine, iv. 383.

[‡] Pyl's Aufsätze und Beob. i. 55.

[§] Henke's Zeitschrift für die Staatsarzneikunde, 1827, ii. 264.

Various eruptions have at times been observed, especially in those who survive several days; and they are more frequent in the kind of cases to be considered afterwards, in which life is prolonged for a week or more. The eruptions which have occurred have been variously described as resembling petechiæ, or measles, or red miliaria; and in one instance a vesicular eruption, said to resemble small-pox, broke out round the mouth and eyes[†]. In the case already quoted from Guilbert a copious eruption of miliary vesicles appeared on the fifth day, and continued to appear for fifteen days afterwards. They were attended with copious perspiration and great abatement of the other symptoms, and were followed with desquamation of the cuticle. Another external affection which may be noticed is general swelling of the body. Several cases of this nature have been described by *Dr Schlegel* of Meiningen; and in one of them the swelling, particularly round the eyes, appears to have been considerable[‡].

In some cases of the kind now under consideration a remission or even a total intermission of all the distressing symptoms has been witnessed, particularly when death is retarded till the close of the second or third day[§]. This remission, which is accompanied with dozing stupor, is most generally observed about the beginning of the second day. It is merely temporary, the symptoms speedily returning with equal or increased violence. Sometimes the remission occurs oftener than once, as in a case related in the London Medical and Physical Journal. The patient, a child seven years old, lived thirty-six hours in a state of alternate calm and excitement; and during the state of calm no pulse was to be felt at the wrists[‖].

In cases such as those now described death often occurs about twenty-four hours after the poison is swallowed, and generally before the close of the third day. But on the one hand life has been sometimes prolonged, without the supervention of the symptoms belonging to a different variety of cases, for five or six days [*], nay perhaps even for several weeks. And, on the other hand, the symptoms of irritation of the alimentary canal are sometimes distinct, although death takes place in a much shorter period than twenty-four hours. *Metzger* has related a striking case, fatal in six hours, in which the symptoms were acute colic pain, violent vomiting, and profuse diarrhœa [†]; *Wildberg* has related a similar case fatal in the same time [‡]; *Hohnbaum* another fatal in five hours [§]; and *Pyl* has recorded another, where all the signs of irritation in the stomach and intestines were present, except vomiting, and which proved fatal in three hours [||]. The last is the shortest undoubted case of poisoning from arsenic which I have hitherto found in authentic records. *Dr Male* has recorded another, which was fatal in four hours [¶]; *Wepfer* another equally short [**]; *Johnston* another fatal in three hours and a-half [††]; and I shall presently mention several which ended fatally in two, five, or six hours [288, 289] [‡‡]. *Wibmer* has even quoted a case fatal in half an hour; but there seems to have been some doubt whether the poison taken was arsenic *.

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[*] Metzger's Materialien für die Staatsarzneikunde, ii. 96.—Lond. Med. Phys. Journ. xxviii. 345—and Wildberg's Praktisches Handbuch, iii. 235–390.

[†] Med. Phys. Journ. xxviii. 345.

[‡] Henke's Zeitschrift für die Staatsarzneikunde, i. 29.

[§] Tonnelier's case. Corvisart's Journal de Médecine, iv.—Roget's case. Med. Chir. Transactions, ii.

[‖] Med. and Phys. Journal, xxviii. 347.

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[*] Henke's Zeitschrift, i. 31.

[†] De Veneficio caute dijudicando. Schlegel's Opusc. iv. 22.

[‡] Praktisches Handbuch für Physiker, iii. 298.

[§] Zeitschrift für die Staatsarzneikunde, ii. 307.

[||] Aufsätze und Beobachtungen, v. 106.

[¶] Elements of Juridical Medicine, 68.

[**] Historia Cicutæ, p. 282.

[††] Essay on Mineral Poisons, 1795, p. 30.

[‡‡] These facts are important, because they will enable the medical jurist in some circumstances to decide a question which may be started as to the possibility or impossibility of arsenic having been the cause of death when it is very rapid. I have dwelt on them more particularly than at first sight may appear necessary, because some loose statements on the subject were made in a controversy on the occasion of a late trial of some note, that of Hannah Russell and Daniel Leny, at Lewes Summer Assizes 1826, for the murder of the husband of the former. Arsenic was decidedly detected in the stomach, and it was proved that the deceased could not have lived above three hours after the only meal at which the prisoners could have administered the poison. Now during the controversy which arose after the execution of one of the prisoners, it was alleged by one of the parties, among other reasons for believing arsenic not to have been the cause of death, that this poison never proves fatal so soon as in three hours,—that Sir Astley Cooper and Mr Stanley of London had never known a case prove fatal in less than seven hours,—and that Dr Male's case mentioned above is the shortest on record. The instances recorded by Pyl and Johnston overthrow this whole line of statement, and render it more than doubtful whether recorded cases had been examined by the disputant with the assiduity which his proposition demanded. It was stated by Mr Evans, the chief crown witness, but I know not on what authority, that, on the trial of Samuel Smith for poisoning, held at Warwick Summer Assizes 1826, the deceas-

Such is an account of the symptoms of poisoning by arsenic in their most frequent form. It will of course be understood that they are liable to great variety as to violence. It must likewise be understood that they are liable to great variety in their mode of combination in actual cases,—and that they are by no means all present in every instance. The most remarkable and least variable of them all, pain and vomiting, are sometimes wanting. A case, in which pain was not felt in the stomach, even on pressure, although the other symptoms of inflammation were present, has been briefly described in the Medical Repository †. A similar case fatal in fourteen hours and a half, where there was much vomiting and some heat in the stomach, but no pain or tenderness, has been related by Dr E. Gairdner of this city ‡. Another very striking example of this anomalous deficiency has been detailed by *Dr Yelloly*. A lad sixteen years old died twenty-one hours after swallowing half an ounce of the white oxide; and the presence of inflammation was denoted all along by sickness, vomiting, purging, and heat in the tongue; yet he never complained of pain, neither did he ever seem to his friends to suffer any. Another anomaly in the case was, that the pulse, contrary to what is usual, was very slow: Twelve hours after he took the poison, the pulse was 40, and two hours before death it was so slow as 30 §. These deviations from the ordinary course of the symptoms are taken notice of merely to put the practitioner on his guard, and prevent the medical jurist from drawing hasty conclusions. Upon the whole, they are rare; and the symptoms of poisoning by arsenic are in general very uniform.

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ed was proved to have expired in two hours after taking a quarter of an ounce of arsenic. I have examined with some care the documents in the Lewes case, which were obligingly communicated to me by Mr Evans; and I have been quite unable to discover any reason for questioning the reality of poisoning, or for the ferment which it seems the subsequent controversy excited. The case seems to have been satisfactorily made out by Mr Evans in the first instance; and no sound medical jurist would for a moment suffer a shadow of doubt to be thrown over his mind by the criticisms of Mr Evans's antagonist.

* Die Wirkung der Arzneimittel und Gifte, i. 271.

† London Medical Repository, ii. 270.

‡ Edinburgh Med. and Surg. Journal, xxxii. 305.

§ Ibidem, v. 389.

2. The second variety of poisoning with arsenic includes a few cases in which the signs of inflammation are far from violent or even altogether wanting, and in which death ensues in five or six hours or a little more,—at a period too early for inflammation to be always properly developed. The symptoms are then by no means so striking as in the first variety, and are referrible chiefly to the mode of action, which is probably the cause of death in most cases,—an action on some remote organ.

These symptoms occasionally amount to absolute narcotism, as in some of the animals on which Mr Brodie experimented. Thus, when he injected a solution of the oxide into the stomach of a dog, the pulse was rendered slow and intermitting; the animal became palsied in the hind-legs and lethargic; in no long time insensible, and with dilated pupils; and soon afterwards it was seized with convulsions, amidst which it died, fifty minutes after the poison was administered *. In man the symptoms very seldom resemble so closely those of the narcotic poisons. A case, however, will be mentioned afterwards, (p. 302,) in which narcotic symptoms alone, namely, stupor, coma, and subsequently weakness of memory were caused by the application of arsenic to the nostrils. The following is an instance of pure narcotic symptoms succeeding and displacing the more usual symptoms of irritation. A young man who got an arsenical solution from an old woman to cure ague, was attacked after taking it with vomiting and loud cries, afterwards with incoherent talking, then fell into a deep sleep, and finally perished in convulsions in five hours †.

In some cases of the kind now under consideration, one or two attacks of vomiting occur at the usual interval after the taking of the poison; but it seldom continues. The most uniform and remarkable affection is extreme faintness, amounting at times to deliquium. Occasionally there is some stupor, or rather oppression, and often slight convulsions. The pain of the epigastrium is generally present; but it is slight, and seldom accompanied with the other signs of internal inflammation. Death commonly takes place in a few hours. Yet, even when it is retarded till the beginning of the second day, the faintness

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* Philos. Transactions, 1812, p. 212.

† *Henke's* Zeitschrift für die Staatsarzneikunde, v. 410.

the symptoms of inflammation in the stomach.

This variety of poisoning has been hitherto observed only under the three following circumstances,—when the dose of poison was large,—when it was in little masses,—or when it was in a state of solution. The mode in which the first and last circumstances operate is evident; they facilitate the absorption of a large quantity of arsenic in a short space of time, so that its remote action begins before the local inflammation is fully developed. But it is not easy to see how any such effect can flow from the arsenic being in little masses. It is probable that none of the circumstances here mentioned are invariable in their operation. At least an instance is related in Rust's Magazin, of the customary signs of irritation having been produced even by the solution *.

On the whole, the present variety of poisoning is rather uncommon, and indeed its existence does not seem to be very generally known. It may be right therefore to specify the cases which have been published.

In the Medical and Philosophical Journal of New York†, is related the case of a druggist, who swallowed an ounce of powdered arsenic at once, and in whom the chief symptoms, after two or three fits of vomiting, were slight pain and heat in the stomach. He died in eight hours, and the stomach was little inflamed.—A similar case has been related by *Professor Metzger*. A young woman died in a few hours, after suffering from trivial diarrhœa, pain in the stomach and strangury; her death was immediately preceded by slight convulsions and fits of suffocation; and on dissection the stomach and intestines were found quite healthy. Half an ounce of arsenic was found in the stomach ‡.—A third case similar in its particulars to the two preceding was submitted to me for investigation by the Sheriff of this county in 1825. The subject, a girl fourteen years of age, took about ninety grains, and died in five hours, having vomited once or twice, complained of some little pain in the belly, and been affected towards the close with great faintness and weakness. The stomach and intestines were healthy §.—A fourth case allied to these is succinctly told in the Medical and Physical Journal. The person expired in five hours; and it is remarkable that vomiting never occurred, even though emetics were given to provoke it[*].—A fifth has been related by *M. Gérard* of Beauvais. The subject was a man much addicted to drinking,—whose daily allowance indeed was a pint of brandy. When M. Gérard first saw him there was so much tranquillity that doubts were entertained whether arsenic had really been swallowed; but at length it was discovered that he had actually arsenic in his mouth and was chewing it. This state continued for nearly five hours, when some vomiting ensued: Coldness of the extremities and spasmodic flexion of the legs soon followed; and in a few minutes more he expired[†]. —A sixth and very singular case of the same kind has been described by *Orfila*. The individual swallowed three drachms at eight in the morning, and went about for two hours bidding adieu to his friends and telling what he had done. He was then prevailed on to take emetics and diluents which caused free, easy vomiting. He suffered very little till one, when he became affected with constricting pain and burning in the stomach, feeble pulse, cold sweats, and cadaverous expression, under which symptoms he died four hours after[‡]. Orfila justly designates this case as the most extraordinary instance of poisoning with arsenic that has come under his notice.—A seventh is related by *Mr Holland* of Manchester where death took place in the course of eight or nine hours, and the symptoms were at first some vomiting, afterwards little else but faintness, sickness, a sullen expression, and a general appearance which led those around to suppose the individual intoxicated[§].—*Professor Chaussier* has described a still more striking case than any yet mentioned. A stout middle-aged man swallowed a large quantity of arsenic in fragments and died in a few hours. He experienced no other symptom except great feebleness and frequent tendency to fainting. The stomach and intestines were not in the slightest degree affected during life; and no morbid appearance could be discovered in them after death[‖].—A similar instance not less remarkable has been communicated to me by *Mr Macaulay* of Leicester, where the individual died with narcotic symptoms only within two hours after taking nearly a quarter of a pound of arsenic.—Another fatal in four hours has been described by *Mr Wright*, where the symptoms were vomiting under the use of emetics, great exhaustion, feeble hurried pulse, cold sweating, drowsiness and finally stupor. In this case the quantity of arsenic taken was about an ounce [*].—Another of the same nature is recorded by *Morgagni*. An old woman stole and ate a cake, which had been poisoned with arsenic for rats. She died in twelve hours, suffering, says Morgagni, rather from excessive prostration of strength than from pain or convulsions [†].—The last I shall mention is described by *M. Laborde*. A young woman was caught in the act of swallowing little fragments of arsenic, and it afterwards appeared that she had been employed most of the day in literally cracking and chewing lumps of it. When the physician first saw her the countenance expressed chagrin and melancholy, but not suffering. After being forced to drink she vomited a good deal, but without uneasiness. Two hours afterwards her countenance was anxious; but she did not make any complaint, and very soon resumed her tranquillity. Five hours after the last portions of the poison were taken she became drowsy, then remained perfectly calm for four hours more, and at length on trying to sit up in bed, complained of slight pain in the stomach, and expired without agony. A clot of blood was found in the stomach [‡].—Other instances of the like nature will be related under the head of Compound Poisoning.

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* Magazin für die gesammte Heilkunde, xxii. 483.

† Vol. iii. quoted in *Kopp's* Jahrbuch, vii. 401.

‡ Materialien für die Staatsarzneikunde, ii. 95.

§ Edin. Med.-Chir. Transactions, ii. 298.

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[*] Lond. Med. Phys. Journal, xxxiv.

[†] Revue Médicale, 1822, vii. 105.

[‡] Archives Générales de Médecine, vii. 14.

[§] London Medical Gazette, xv. 828.

[‖] Orfila, Toxicologie Générale, i. 397.

The twelve cases of which an abstract has here been given will, it is apprehended, be sufficient to correct an erroneous impression which some entertain,—that arsenic, when it proves fatal, always produces violent and well-marked symptoms. It will of course be understood that cases of the present kind pass by insensible shades into those of the first class,—the following, for example, being intermediate between the two. A young man had frequent vomiting and diarrhœa, which were supposed to depend on indigestion merely, as the countenance was calm, without any appearance of suffering, the appetite tolerable, and the abdomen quite free of tenderness. The pulse, however, quickly sunk, the voice failed, and death took place in eleven hours; and on dissection about twenty grains of arsenic were found in the stomach, with strong signs of inflammation [*].

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[*] Lancet, xvi. 612.

[†] Epist. Anat. lix. 3.

[‡] Journal de Médecine, lxx. 89.

3. The third variety of poisoning with arsenic places in a clear point of view its occasional action on the nervous system. This occurs chiefly in persons who, from having taken but a small quantity, or from having vomited soon after, are eventually rescued from destruction; but it has also been met with in some cases where death ensued after a protracted illness.

In such cases the progress of the poisoning may be divided into two stages. The first train of symptoms is exactly that of the first or inflammatory variety, and is commonly developed in a very perfect and violent form. In the second stage the symptoms are referrible to nervous irritation.

These generally come on when the former begin to recede; yet sometimes they make their appearance earlier, while the signs of inflammation in the alimentary canal continue violent; and more rarely both classes of symptoms begin about the same period. The nervous affection varies in different individuals. The most formidable is coma; the slightest, a peculiar, imperfect palsy of the arms or legs, resembling what is occasioned by the poison of lead; and between these extremes have been observed epileptic fits or tetanus, or an affection resembling hysteria, or mania. As these affections are of much interest, in respect to the evidence of poisoning from symptoms, it may be well to relate in abstract a few characteristic examples of each.

A good example of epilepsy supervening on the ordinary symptoms of inflammation has been minutely related by *Dr Roget*. A girl swallowed a drachm of arsenic, and was in consequence attacked violently with the usual symptoms of irritation in the whole alimentary canal. After being ill about twenty-four hours she experienced several distinct remissions and had some repose, attended with fainting. In twelve hours more she began to improve rapidly; the pain subsided, her strength and spirits returned, and the stomach became capable of retaining liquids. So far this patient laboured under the common effects of arsenic. But a new train of symptoms then gradually aprassed with frightful dreams, starting from sleep, and tendency to faint; and next morning she complained of coldness along the spine, giddiness, and intolerance of light. On the fourth day she had also aching of the extremities and tingling of the whole skin. These symptoms continued till the close of the sixth day, when she was suddenly seized with convulsions of the left side, foaming at the mouth, and total insensibility. The convulsions endured two hours, the insensibility throughout the whole night. Next evening she had another and similar fit. A third, but slighter fit occurred on the morning of the tenth; another next day at noon; and they continued to return occasionally till the nineteenth day. For some time after that she was affected with a sense of tightness across the chest and with stomach complaints; but she was eventually restored to perfect health*.

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[*] Journal Hebdomadaire, 1832, viii. 476.

A characteristic set of similar cases, which occurred in London in 1815, has been related in a treatise on arsenic by *Mr Marshall*†. They were the subject of investigation on the trial of Eliza Fenning, a maid-servant, who attempted to poison the whole of her master's family by mixing arsenic with a dumpling, and whose condemnation excited an extraordinary sensation at the time, as many persons believed her to be innocent. Five individuals partook of the poisoned dish, and they were all violently seized with the usual inflammatory symptoms. But farther, one had an epileptic fit on the first day, which returned on the second; and he had besides frequent twitches of the muscles of the trunk, a feeling of numbness in one side, and heat and tingling of the feet and hands. Another had tremors of the right arm and leg on the first day, and several epileptic fits in the course of the night. During the next fifteen days he had a paroxysm every evening about the same hour; which returned after an intermission of eight days, and continued to appear frequently for several months.

In the following set of cases the nervous symptoms exhibited a singular combination of delirium, convulsions, tetanus, and coma, such as is frequently met with in paroxysms of hysteria; but the cases are probably not pure examples of poisoning with arsenic, for liver of sulphur was administered as a remedy to a considerable amount. Three servant girls in one of the Hebrides ate a mixture of lard, sugar and arsenic, which had been laid for destroying rats. The ordinary signs of irritation in the stomach ensued, but on the following morning were greatly mitigated. They were then ordered twelve grains of liver of sulphur every other hour. Soon afterwards the inflammatory symptoms became more severe, the root of the tongue swelled and inflamed, and in the afternoon two of them lost the power of speech and swallowing, and were attacked with locked-jaw and general convulsions. The third had not locked-jaw, but was otherwise similarly affected. On the morning of the third day one of the two former was found comatose, with continuance of the locked-jaw and occasional return of convulsions; and on being roused by venesection and the cold affusion she complained of headach and heat in the throat. The sulphuret of potass, which had been discontinued on account of the locked-jaw, was then resumed. On the evening of the fourth day the headach increased, and the patient became delirious and unmanageable. The cold affusion, however, soon restored her again to her senses, and from that time her recovery was progressive. In the other patients the symptoms were similar, but less violent. In these instances the evidence of an injury of the nervous system was decisive; but it may be doubted whether the symptoms were not, in part at least, owing to the sulphuret of potass, which has been already described as an active poison, capable of inducing convulsions and tetanus. Its properties were not generally known in this country at the time the cases in question happened*.

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* London Med.-Chir. Transactions, ii. 134.

† See also a full abstract in Edin. Med. and Surg Journal, xiii. 507.

Sometimes the convulsions caused by arsenic assume the form of pure tetanus. At least a case of this affection is noticed by *Portal*†. He has given only a mere announcement of it; and I have not hitherto met with a parallel instance in authors.

A very common nervous affection in the advanced stage of the more tedious cases of poisoning with arsenic is partial palsy. Palsy in the form of incomplete paraplegia is a very common symptom even of the early stage in animals, and has been also sometimes observed during that stage in man. The paralytic affection, however, is more frequent in the advanced stage; and in those persons who recover, an incomplete paralysis of one or more of the extremities, resembling the lead-palsy, is very often the last symptom which continues.

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* Edin. Med. and Surg. Journal, xv 553.

† Traitement des Asphyxiés, 135.

Dehaen relates a distinct example of this disorder occurring in a female who took a small quantity of arsenic by mistake. The ordinary signs of inflammation were soon subdued, and for three days she did well; but on the fourth she was attacked with cramps, tenderness, and weakness of the feet, legs and arms, increasing gradually till the whole extremities became at length almost completely palsied. At the same time the cuticle desquamated. But the other functions continued entire. The power of motion returned first in the hands, then in the arms, and she eventually recovered; but eleven months passed before she could quit the hospital where Dehaen treated her [*].

An excellent account of a set of similar cases has been given by *Dr Murray* of Aberdeen. They became the subject of judicial inquiry on a noted trial, that of George Thom, who was condemned in 1821 at the Aberdeen Autmn Circuit for poisoning his brother-in-law. Four persons were simultaneously affected about an hour after breakfast with the primary symptoms of poisoning with arsenic, and some in a very violent degree. But besides these symptoms, in all of them the muscular debility was very great; and in two it amounted to true partial palsy. One of them lost altogether the power of the left arm, and six months after, when the account of the cases was published, he was unable to bend the arm at the elbow-joint. The other had also great general debility and long-continued numbness and pains of the legs [†].

A well-marked case of the same nature has been noticed by *Professor Bernt.* It was the case formerly alluded to as arising from an over-dose of the arseniate of potass. The paralytic affection consisted in the loss of sensation and of the power of motion in the hands, and of the loss of motion in the feet, with contraction of the knee-joints. The issue of the case is not mentioned [‡].

Dr Falconer observes in his essay on Palsy, that he has repeatedly witnessed local palsy after poisoning with arsenic, and alludes to one instance in which the hands only were paralyzed, and to two others in which the palsy spread gradually from the fingers upwards till the whole arms were affected [*]. On the whole, local palsy appears to be the most frequent of the secondary effects of arsenic.

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[*] Ratio Medendi, iii. 113.

[†] Edin. Med. and Surg. Journal, xviii. 167.

[‡] Beiträge zur gerichtlichen Arzneikunde, iv. 221.

It is sometimes very obstinate, as the cases related by Dehaen and Murray will show. But it even appears to be sometimes incurable. For in the German Ephemerides there is related the case of a cook, who after suffering from the usual inflammatory symptoms, was attacked with perfect palsy of the limbs, and had not any use of them during the rest of her life, which was not a short one [†].

Occasionally, instead of being palsied, the limbs are rigidly bent and cannot be extended [‡]. They were contracted, as well as palsied in the case noticed by Bernt.

The last nervous affection to be mentioned is mania. The only instance I have hitherto found of that disease arising from arsenic is related by *Amatus Lusitanus*. He has not recorded the particulars of the case, but merely observes that the individual became so outrageously mad as to burst his fetters and jump out of the window of his apartment [§]. According to Zacchias, Amatus was not very scrupulous in his adherence to fact in recording cases.

The preceding remarks contain all that is known with certainty of the effects of arsenic on man when it is swallowed. Independently of the obvious nervous disorders which succeed the acute symptoms, other morbid affections of a more obscure character and chronic in their nature have been sometimes observed or supposed to arise from this poison. Among these the most unequivocal is dyspepsia. Irritability of the stomach, attended with constant vomiting of food, has been occasionally noticed for a long time after. *Wepfer* has described two cases in which the primary symptoms were followed, in one by dyspepsia of three years standing, in the other by emaciation and an anomalous fever, which ended fatally in three years [*]. *Hahnemann* farther adds, that in the advanced stage the hair sometimes drops out, and the cuticle desquamates, accompanied occasionally with great tenderness of the skin[†]; and *Wibmer* mentions a case of the kind, where not the cuticle and hair only, but likewise even the nails, fell off [‡]. Desquamation of the cuticle and dropping of the nails are at times produced by the continued use of arsenic in medicinal doses. Other effects have likewise been ascribed to its employment medicinally. Thus, passing over what was stated by its opponents at the time when its introduction into the materia medica was made the subject of controversy over Europe, *Broussais* maintains that it causes chronic inflammation of the stomach or intestines [§]; and *Dr Astbury* infers, from an instance which fell under his notice, that it may bring on dropsy [||]. Neither of these ideas is supported by the general experience of the profession; and although some persons even of late have alleged that those, who take it medicinally to any material amount, invariably die soon after of some chronic disease [¶], there cannot be a doubt, that, under proper restriction, it is both an effectual and a safe remedy.

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[*] Mem. of London Medical Society, ii. 224.

[†] Nova Acta Naturæ Curiosorum, iii. 532.

[‡] Hahnemann über die Arsenic-Vergiftung, 59.

[§] Curationes Medicinales. Cent. ii. Obs. 33.

In the present place may also be considered the supposed effects of the celebrated *Aqua Toffana*, or *Acquetta di Napoli*, a slow poison, which in the sixteenth century was believed to possess the property of causing death at any determinate period, after months for example, or even years of ill health, according to the will of the poisoner.

The most authentic description of the Aqua Toffana ascribes its properties to arsenic. According to a letter addressed to Hoffmann by Garelli, physician to Charles the VI. of Austria, that Emperor told Garelli, that, being Governor of Naples at the time the Aqua Toffana was the dread of every noble family in the city, and when the subject was investigated legally, he had an opportunity of examining all the documents,—and that he found the poison was a solution of arsenic in *aqua cymba-*

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[*] Cicutæ Aquaticæ Historia et Noxæ, 280.

[†] Uber die Arsenic-Vergiftung, 61.

[‡] Die Wirkung der Arzneimittel und Gifte, i. 266.

[§] Dict. des Sciences Méd. ii. 307.

[||] Edin. Med. and Surg. Journal, xv. 415.

[¶] *Cadet de Gassicourt.* Article Arsenic in Dict. des Sc. Méd.

lariæ [*]. The dose was said to be from four to six drops. It was colourless, transparent, and tasteless, just like water.

Its alleged effects are thus eloquently described by *Behrends*, a writer in Uden and Pyl's Magazin. "A certain indescribable change is felt in the whole body, which leads the person to complain to his physician. The physician examines and reflects, but finds no symptom, either external or internal,—no constipation, no vomiting, no inflammation, no fever. In short, he can advise only patience, strict regimen, and laxatives. The malady, however, creeps on; and the physician is again sent for. Still he cannot detect any symptom of note. He infers that there is some stagnation or corruption of the humours, and again advises laxatives. Meanwhile the poison takes firmer hold of the system; languor, wearisomeness, and loathing of food continue; the nobler organs gradually become torpid, and the lungs in particular at length begin to suffer. In a word, the malady is from the first incurable; the unhappy victim pines away insensibly, even in the hands of the physician; and thus is he brought to a miserable end through months or years, according to his enemy's desire [†]." An equally vigorous and somewhat clearer account of the symptoms is given by *Hahnemann*. "They are," says he, "a gradual sinking of the powers of life, without any violent symptom,—a nameless feeling of illness, failure of the strength, slight feverishness, want of sleep, lividity of the countenance, and an aversion to food and drink and all the other enjoyments of life. Dropsy closes the scene, along with black miliary eruptions and convulsions, or colliquative perspiration and purging [‡]."

Whatever were its real effects, there appears no doubt that it was long used secretly in Italy to a fearful extent, the monster who has given her name to it having confessed that she was instrumental in the death of no less than six hundred persons. It has been already stated, however, [p. 36,] that she owed her success rather to the ignorance of the age than to her own dexterity. At all events, the art of secret poisoning cannot now be easily practised. Indeed even the vulgar dread of it is almost extinct. Partly on account of the improvement in general knowledge, and chiefly in consequence of the subtility and pre-

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[*] Hoffmann, Medicina Rationalis Systematica, i. 198.

[†] Magazin für die gerichtlichen Arnzeikunde, ii. 473.

[‡] Ueber die Arsenic-Vergiftung, 63.

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cure an inveterate itch with an arsenical lotion, was attacked in consequence with severe erysipelas of the whole body, succeeded by tremors and gradual exhaustion of the vital powers, ending fatally in two years [*].

Next as to ulcers; *M. Roux* has noticed the case of a girl, who was killed by the application of the arsenical paste to an ulcer of the breast, and in whom the constitutional symptoms were strongly marked, although the quantity of the poison must have been very small. The preparation used, which contains only a twenty-fourth of its weight of arsenic, was applied for a single night on a surface not exceeding an inch and a-half in diameter. Yet she complained next day of violent colic and vomited frequently, the countenance soon became collapsed, and she died two days afterwards in great anguish [†]. Another instance of the like kind is related in the Annales d'Hygiène, where death arose from an arsenical ointment ignorantly applied for scirrhous breast over a large surface of the skin stripped of the cuticle by a blister. The particular symptoms and their duration are not stated; but there was violent irritation of the stomach [‡].

There is a singular uncertainty in the effects of arsenic when applied to ulcerated surfaces. Some persons, like Roux's patient, are obviously affected by a single application; while others have had it applied for a long time without experiencing any other consequence than the formation of an eschar at the part. Two causes have been assigned for these differences, and probably both are founded on fact. One cause, which has been assigned by *Mr Blackadder*, is the relative quantity of arsenic applied. He says he never witnessed but one instance of its acting constitutionally, although he often applied it to sores; and he imputes this success to his having always used a large quantity. For he considers that by so doing the organization of the part is quickly destroyed, and absorption prevented,—but that if the quantity be small, as in the mode practised by Roux, it will cause little local injury and readily enter the absorbing vessels [§]. Another unequivocal cause is pointed out by *Harles* in his treatise on arsenic. While treating of its therapeutic properties, and noticing the controversy that prevailed not long ago throughout Europe respecting the propriety of its outward application, he remarks that it may be applied with safety to the abraded skin, to common ulcers, to wounded surfaces, and to malignant, glandular ulcers, even when highly irritable, provided the part be not recently wounded, so as to pour out blood *. The reason of this is obvious; the application of the poison to open-mouthed vessels is the next thing to its direct introduction into a vein. It is a curious confirmation of Harles's opinion, that Roux, whose patient was so easily affected, recommends that before arsenic is applied to an ulcer, a fresh surface be made by paring away the granulations.

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[*] Cours de Médecine Légale, p. 121.

[†] Elémens de Médecine Opératoire.

[‡] Annales d'Hyg. Publ. et de Méd. Lég. xi. 461.

[§] On Phagedæna Gangrænosa, or Med. Phys. Journal, xl. 238.

In the cases related above it will be remarked that the symptoms vary in their nature. Sometimes the chief disorder is inflammation, spreading over and around the eruption or ulcer, sometimes inflammation of the alimentary canal, sometimes an affection of the nervous system. In general the sufferings of the patient both from the local inflammation and constitutional symptoms are very severe. But this rule has its exceptions. In *Pyl's* Memoirs there is the history of a child who died four days after an itchy eruption of the whole body had been washed with an arsenical solution, and signs of vivid inflammation were found after death in many parts; yet she appears to have complained only of headach †. Occasionally too, without exciting either inflammation of the part, or disorder of the stomach, or a general injury of the nervous system, it seems to give rise to partial palsy of the muscles adjoining the seat of its application. An extraordinary case is noticed in an American Journal, in which the prolonged use of an arsenical preparation for destroying a tumour on the right side of the neck, was followed by complete palsy of the muscles of the neck and arm of that side.

In the next place, poisoning has been perpetrated by introducing arsenic into the fundament with an injection ‡. *Foderé* has noticed a case of this kind, which happened in France, and was communicated to him by a physician of Thoulouse. A lady was under medical treatment for some trifling illness, but died very unexpectedly under symptoms of poisoning; and it was discovered that her servant, after unsuccessfully attempting to despatch her by dissolving arsenic in her soup, had ultimately succeeded by administering arsenic repeatedly in injections *. There is no doubt that by this mode all the usual effects of arsenic may be induced; and on account of the facility with which the colon and rectum may be evacuated, it is not very likely that the poison will be found in the body after death, if the individual did not die in a few hours after its administration.

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* De Arsenici usu in Medicina, p. 158.

† Aufsätze und Beobachtungen, i. 43.

‡ Paris and Fonblanque, ii. 222.

In the third place, women have also died of poisoning by arsenic introduced into the vagina. Two examples of this revolting crime are on record. One of them occurred in 1799, in the Department of the Ourthe in France. A middle-aged female was seized with vomiting, diarrhœa, swelling of the genitals and uterine discharge, and she expired not long after. Before her death she told two of her neighbours, that her husband had some time before tried to poison her by putting arsenic in her coffee, and had at length succeeded by introducing a powder into her vagina while in the act of enjoying his nuptial rights. The vulva and vagina were gangrenous, the belly distended with gases, and the intestines inflamed †.

The other case, which happened in Finland in 1786, gave rise to an excellent dissertation on the subject by *Dr Mangor*, at that time medical inspector for Copenhagen. A farmer near Copenhagen lost his wife suddenly under suspicious circumstances, and six weeks afterwards married his maid-servant. In a few years he transferred his affections to another maid-servant, with whose aid he endeavoured to poison his second wife. For some time his attempts proved abortive; till at last one morning, after coïtion, he introduced a mixture of arsenic and flour on the point of his finger into the vagina. She took ill at mid-day and expired next morning; and the murderer soon after married his guilty paramour. But a few years had not elapsed before he got tired of her also; and one morning, after the conjugal embrace, he administered arsenic to her in the same way as to her predecessor. About three in the afternoon, while enjoying good health, she was suddenly seized with shivering and heat in the vagina. The remembrance of her former wickedness soon awoke the suspicions of the unfortunate woman, and she wrung from her husband a confession of his crime. Means were resorted to for saving her life, but in vain: She was attacked with acute pain in the stomach and incessant vomiting, then became delirious, and died in twenty-one hours. After death grains of arsenic were found in the vagina, although frequent lotions had been used in the treatment. The labia were swollen and red, the vagina gaping and flaccid, the os uteri gangrenous, the duodenum inflamed, the stomach natural. In the course of the judicial proceedings which arose out of these two cases, Dr Mangor made experiments on mares, with the view of settling the doubts which were entertained as to the likelihood of arsenic proving fatal in the manner alleged; and the results clearly showed that when applied to the vagina of these animals, it produces violent local inflammation and fatal constitutional derangement *.

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* Médecine Légale, iv. 226.

† Ansiaulx, Clinique Chirurgicale, and Henke's Zeitschrift für die Staatsarzneikunde, ii. 188.

In the fourth place, poisoning by arsenic through the bronchial membrane or membrane of the air-passages is a rare accident, which can take place only in consequence of arsenical vapours being incautiously breathed. The effects of the poison when introduced in this way are well described from personal experience by *Otto Tachenius*, a chemist of the sixteenth century. "Once," says he, "when I happened to breathe incautiously the fumes of arsenic, I was surprised to find my palate impressed with a sweet, mild, grateful taste, such as I never experienced before. But in half an hour I was attacked with pain and tightness in the stomach, then with general convulsions, difficult breathing, an unspeakable sense of heat, bloody and painful micturition, and finally with such an acute colic as contracted my whole body for half an hour." By the use of oleaginous drinks he recovered from these alarming symptoms; but during all the succeeding winter he had a low hectic fever †.

Balthazar Timæus relates a similar case, which came under his notice. An apothecary of Colberg, while subliming arsenic, had not been careful enough to avoid the fumes; and was soon after seized with frequent fainting, tightness in the præcordia, difficult breathing, inextinguishable thirst, parched throat, great restlessness, watching, and pains in the feet. He had afterwards profuse daily perspiration and palsy of the legs; and several months elapsed before he got entirely well[*]. The same author says that the famous Paracelsus, being one day put out of temper by an acquaintance, made him hold his nose over an alembic in which arsenic was subliming; and that the object of this severe joke nearly lost his life in consequence. Wibmer quotes the heads of several cases where swelling of the tongue, headach and giddiness, nausea and an oppressive sense of constriction in the throat were occasioned by the incautious inhalation of arsenical fumes[†]. The following extraordinary case, closely allied to malignant cholera in its early stage, has been ascribed by the reporter *Dr Welper* of Berlin to the inspiration of arsenical fumes,—with what probability I am not prepared to say. A stout healthy man, who in the forenoon had freely and for some time exposed himself to the steam from a vessel where he was boiling several ounces of orpiment in water, was attacked at night with sickness, and next morning with extreme weakness and some difficulty of breathing. These symptoms were greatly relieved by an emetic. But towards evening the extremities became ice-cold and very stiff, the breathing much oppressed, the pulse very hurried and imperceptible except in the neck, the mouth and throat dry and the tongue rigid; but the mind remained clear, though anxious and afraid of impending dissolution. His state of collapse was removed in twelve hours by fomentations, and in no long time he recovered entirely except from the dyspnœa, which continued more or less till a few years afterwards when he died of hydrothorax[‡].

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* Acta Hafniensia, iii. 178.

† Hippocrates Chymicus, c. 24, p. 213.

It would appear that arsenic acts with great rapidity and force when its fumes are respired.

Poisoning through the lining membrane of the nostrils is a still rarer accident than that last mentioned. There is a distinct example of it in the German Ephemerides, which arose from an arsenical solution having been used by mistake as a lotion for a chronic discharge from the nostrils. The individual was attacked with a profuse discharge from the nostrils, and then with

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[*] Casus Medicinales, lib. vii. cas. 11.

[†] Die Wirkung der Arzneimittel und Gifte, i. 299.

[‡] Journal der Praktischen Heilkunde, lxxii. v. 134.

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wards swelled much, and the pustules spread all around it; he was tormented with intolerable heat in the scalp; and the hair became matted with the discharge into a thick scabby crust. This crust separated in a few weeks, and he soon recovered completely [*]. *Sehulze*, a German physician, has related no fewer than five cases of the same description, all arising from arsenic having been mistaken for hair-powder; and one of them proved fatal. Two of the cases were slight. The other persons had the same violent inflammation of the head as Desgranges' patient and the German school-boy. In the fatal case death took place in twenty-one days; and on dissection, besides other morbid appearances, the scalp was found gangrenous and infiltered with fluid blood, and the stomach much inflamed [†]. The two survivors, who were severely ill, it is well to add, were not attacked with the erysipelas of the scalp till six days after they powdered themselves. *Sproegel* mentions a fatal case from fly-powder having been applied in like manner to the head; and *Wibmer* quotes another not fatal, where from the same cause great swelling of the head and face arose, followed by erysipelas of the face, neck, and belly, and a papular eruption on the hands which continued five days [‡].

From the statements now made, it is evident that arsenic applied to various parts of the external surface and natural apertures of the body, will prove poisonous, and will often act with a certainty and rapidity not surpassed by its effects when taken internally. Many of the cases furnish a striking confirmation of a circumstance formerly noticed with respect to its action,—namely, that it produces signs of irritation in the stomach, in whatever manner it is introduced into the body. In some instances, indeed, the signs of inflammation in the stomach were quite as distinct as in the cases previously described, where the poison was taken internally.

The subject of the symptoms caused by arsenic will now be concluded with a few remarks on the strength of the evidence which they supply.

The present doctrine of toxicologists and medical jurists supply decisive proof of the administration of arsenic. This opinion is certainly quite correct when applied to what may be called a common case of poisoning with arsenic, the symptoms of which are little else than burning pain in the stomach and bowels, vomiting and purging, feeble circulation, excessive debility and speedy death. All these symptoms may be caused by natural disease, more particularly by cholera; and consequently every sound medical jurist will join in condemning unreservedly the practice which prevailed last century of deciding questions of poisoning in such circumstances from symptoms alone. But modern authors appear to have overstepped the mark, when they hold that the rule against deciding from symptoms does not admit of any exceptions. For there are cases of poisoning with arsenic, not numerous certainly, yet not very uncommon neither, which can hardly be confounded with natural disease; and, what is of some consequence, they are precisely those in which the power of deciding from symptoms alone is most required, because the chemical evidence is almost always wanting. Either the peculiar combination of the symptoms is such as cannot arise from natural causes, so far at least as physicians are acquainted with them: Or these symptoms occur under collateral circumstances, which put natural causes almost or altogether out of the question.

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[*] Acta Germanica, ii. 33.

[†] Knape und Hecker's Kritische Annalen der Staatsarzneikunde, i. 143–159.

[‡] Die Wirkung der Arzneimittel und Gifte, i. 241.

Thus, let the medical jurist consider in the first place, the symptoms occasionally observed in those who survive five, six or ten days; let him exclude for the present the secondary nervous affections; and instead of a compounded description, which may be objected to as apt to convey a false and exaggerated idea of the facts, let him take an actual example. In a paper by *Dr Bachmann* on some cases of poisoning with arsenic, there is a minute account of the case of a lady who was poisoned by her maid with fly-powder and white arsenic, and whose symptoms were those of universal inflammation of the mucous membranes. After suffering two days from retching and vomiting, colic pains and purging, these symptoms suddenly became more violent, and attended with oppressed breathing and hoarseness so that she could hardly make herself be heard,—with vesicles on the palate, burning pain in the throat, and excessive difficulty in swallowing,—with spasm and pain of the bladder in passing water,—and with extreme feebleness of the pulse. Three days afterwards the symptoms increased still more. She complained of intolerable burning and spasms of the throat, which, as well as the mouth, was excessively inflamed,—of violent burning pain in the stomach and bowels,—of burning in the fundament and genitals, both of which were inflamed even to gangrene,—of indescribable anxiety and anguish about the heart; and she died the following day, death being preceded by subsultus, delirium, and insensibility [*]. Or take the case in the trial of Miss Blandy. On two successive evenings, immediately after taking some gruel which had been prepared by the prisoner, Mr Blandy was attacked with pricking and burning of the tongue, throat, stomach, and bowels, and with vomiting and purging. Five days after, when the symptoms were fully formed, he had inflamed pimples round the lips, and a sense of burning in the mouth; the nostrils were similarly affected; the eyes were bloodshot and affected with burning pain; the tongue was swollen, the throat red and excoriated, and in both there was a tormenting sense of burning; he had likewise swelling, with pricking and burning pain of the belly; excoriations and ulcers around the anus, and intolerable burning there; vomiting and bloody diarrhœa; a low, tremulous pulse, laborious respiration, and great difficulty in speaking and swallowing. In this state he lingered several days, death supervening nine days after the first suspected basin of gruel was taken [†]. Can the symptoms, in these two cases, attacking, as they did, at one and the same time, the whole mucous membranes, be imitated by any natural combination of symptoms? Viewing the endless variety and wonderful complexity of the phenomena of disease, the practitioner will probably, and with justice, reply that a natural combination of the kind is possible. But if his attention is confined, as in strictness it ought, to real occurrences,—if he is required to speak only from actual experience, personal or derived, it is exceedingly questionable whether any one could say he had ever seen or read of such a case. At all events, if a medical witness had to give his opinion from symptoms only in such a case as that of Mr Blandy, or that described by Bachmann, he would certainly be justified in declaring that poisoning was highly probable; and, admitting general poisoning to be proved, he would, it is likely, fix on arsenic as the substance which could most easily produce the effects.

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[*] Einige auserlesene Medizinisch-gerichtliche abhandlungen von Schmitt, Bachmann, &c. p. 40.

[†] State Trials, xviii.

Let him next, however, take also into consideration the nervous affections that sometimes either immediately follow the inflammation of the mucous membranes, or become united with it, when it has existed a few days; and, confining his attention still to actual occurrences, let him reflect on the symptoms in *Dr Roget's* case, in which there was first violent inflammation of the whole alimentary canal, and then regular and obstinate epilepsy, (p. 290,) or on those in Dehaen's patient, in whom the nervous disorder was partial palsy, (p. 293.) On reconsidering these narratives, still greater reason will appear for doubting whether such a combination of simultaneous, and in the present instance also consecutive symptoms, ever arises from natural causes. It is difficult to conceive a fortuitous concurrence of natural diseases producing at the same moment that variety and complexity of disorders which occur in the primary stage of the cases alluded to; and it would surely be a still more extraordinary combination which should farther add the supervention of epilepsy or partial palsy from a natural cause, at the exact period at which it appears as the secondary stage of poisoning with arsenic. All that any practitioner could say is, that a concurrence of the kind is within the bounds of possibility. He must be compelled to admit that it is in the highest degree improbable, and likewise that it could hardly take place from natural causes without the real causes of the symptoms being clearly indicated.

But to conclude, there are likewise collateral circumstances connected with the symptoms, which, taken along with the symptoms themselves, will sometimes place the fact of poisoning with arsenic beyond the reach of a doubt. Thus, if a person were taken several times ill with symptoms of general inflammation of the mucous membranes, after partaking each time of a suspected article of food or drink, the proof of the administration of arsenic would be very strong indeed; and it would be unimpeachable if at length a nervous affection succeeded at the usual period. Or above all, suppose several persons, who have partaken of the same dish, are seized about the same time with nearly the same symptoms of irritation of the mucous membranes. The proof of general poisoning would then be unequivocal. And if one or more of them should afterwards suffer from a nervous disorder, little hesitation ought to be felt in declaring that arsenic is the only poison which could have caused their complaints.

These views are of more practical consequence than may at first sight be thought. The doctrine which has been here espoused might have been applied to decide two criminal cases which lately made a great noise in this country. One was the case of Eliza Fenning (p. 291.) Here five persons were simultaneously attacked with symptoms, more or less violent, of inflammation of the whole alimentary canal; and in two of them epileptic convulsions appeared before the inflammatory symptoms departed. The other was the case of George Thom (p. 293.) Here four persons were at one and the same time seized with the primary symptoms in an aggravated form; and in two of them, as these symptoms abated, obstinate partial palsy came on. On both trials, then, it might have been stated from the symptoms alone that poison had been given, and that arsenic was the only poison hitherto known to be capable of producing such effects.

In applying this doctrine to parallel instances two precautions must be attended to. On the one hand, care must be taken to ascertain, as may always be done, that the simultaneous symptoms of general irritation in the alimentary canal, arising soon after a meal, are not owing to unsound meat having been used in preparing it. And on the other hand, which is of more consequence, the symptoms on which so important an opinion is founded, must be strongly marked and well ascertained by a competent person. The signs of irritation in the mucous membranes must be really general and unequivocal; and those of a disorder of the nervous system must be likewise developed characteristically. Care must be taken in particular to distinguish symptoms of the latter class from others which approach to them in nature, and are the ordinary sequels of natural disease: For example the true palsy caused by arsenic must not be confounded with the numbness and racking pains in the limbs, which occasionally succeed cholera.

With these precautions the evidence from symptoms may in certain cases be decisive of the question of poisoning with arsenic. And it is of moment to observe, as has been already hinted, that, although such cases are not numerous, they are precisely of the kind in which it is most essential to the ends of justice that the symptoms should, if possible, supply evidence enough to direct the judgment; for the characteristic symptoms referred to occur chiefly when the patient either recovers or survives many days, and where consequently the chemical evidence, usually procured from the examination of the contents of the stomach, is almost always wanting.

SECTION III.—*Of the Morbid Appearances caused by Arsenic.*

The morbid appearances caused by Arsenic will next require some details. In treating of them the same plan will be pursued as in the preceding section: The various morbid appearances left by it will first be mentioned in their order; and the subject will then be wound up with some remarks on the force of the evidence from these appearances, as they are usually combined in actual cases.

In the first instance, there are some cases in which little or no morbid appearance is to be seen at all. These all belong to the second variety of poisoning, which is characterized by the absence of local inflammation, and the presence of symptoms indicating an action on the heart, or some other remote organ. In such circumstances death takes place before a sufficient interval has elapsed for inflammation to be developed.

Several examples of the absence of diseased appearances in the dead body are to be found in authors. Thus in *Chaussier's* case, formerly quoted, (p. 288), in that related by *Metzger*, (p. 287), in another related by *Etmuller*, which was fatal in twelve hours *, and in a fourth related by *Professor Wagner* of Berlin, where life was also prolonged for twelve hours under incessant vomiting †, there was positively no morbid alteration at all. Such was also the state of the whole alimentary canal in the extraordinary case related by *Orfila*. In the case quoted from the Medical and Physical Journal (p. 288), there was merely a slight redness at the pyloric end of the stomach. In the case of the American grocer too, there was only a little redness. In *Mr Wright's* case (p. 289), there was scarcely any morbid appearance,—nothing more than two small vascular spots and a minute ecchymosis. In that which fell under my own notice (p. 287), the villous coat of the stomach was of natural firmness, and had an exceedingly faint mottled-cherry-red tint, barely perceptible in a strong light; and the rest of the alimentary canal, as well as the body generally, was quite healthy.

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* Ephem. Academ. Cæsareo-Leopoldinæ, 1715. Obs. cxxvi.

† *Horn's* Archiv. für Medizinische Erfahrung, 1834, 755.

Although in these examples the morbid appearances were trifling or undistinguishable, it must not be supposed that the same happens in all cases of very rapid death from arsenic. In *Gérard's* case, where the usual irritant symptoms were wanting, and which proved fatal in five hours, there was dark redness of the whole villous coat of the stomach. In *Mr Holland's* case, fatal in eight or nine hours, (p. 288), the stomach was of an intense purple colour at its pyloric end, and contained bloody mucus; and the mucous coat of the cœcum presented extensive softening and congestion. There is also an instance related by *Pyl* of this poison proving fatal in ten hours, and leaving nevertheless in the dead body distinct signs of violent irritation; nay in another case related by the same author there were signs of inflammation in the stomach, though death took place in three hours only *. Whenever the symptoms have clearly indicated inflammation, corresponding appearances may be detected in the dead body.

In the ordinary cases in which death is delayed till the second day or later, a considerable variety of diseased appearances has been observed. They are the different changes of structure arising from inflammation in the alimentary canal, in the organs of the chest, and in the organs of generation—together with certain alterations in the state of the blood and condition of the body generally.

The first set of appearances to be mentioned are those indicating inflammation of the alimentary canal, viz. redness of the throat and gullet,—redness of the villous and peritonæal coats of the stomach, blackness of its villous coat from extravasation of blood into it, softening of the villous coat, ulceration of that as well as of the other coats, effusion of coagulable lymph on the inner surface of the stomach, extravasation of blood among its contents,—finally, redness and ulceration of the duodenum and other parts of the intestinal canal, and more particularly of the rectum; to which may also be added, though not properly a morbid phenomenon, certain appearances put on by the arsenic which remains undischarged.

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* Aufsätze und Beobachtungen, i. 53, and v. 107.

Redness of the throat and gullet is not common, at least it does not often occur in the descriptions of cases. *Jaeger*, however, says that in his experiments he usually found redness at the upper and purplish stripes at the lower end of the gullet [*]; and *Dr Campbell* likewise found the gullet red in animals [†]. Similar appearances have also been remarked in man. In the case of a man who lived eight days, *Dr Murray* found the gullet very red [‡]; in that of a woman who lived scarce seven hours, *Dr Booth* observed the gullet inflamed downwards very nearly to the cardia [§]; and *Wildberg* has reported two cases of the same nature, in one of which it is worthy of remark that the poisoning lasted only six hours [‖]. On the whole, it appears probable that inflammation of the throat and gullet would be found more frequently in the reports of cases, if it was more carefully looked for.

Redness of the inner coat of the stomach is a pretty constant effect of arsenic, when the case is not very rapid. All the varieties of redness, formerly mentioned among the effects of the irritant poisons generally, may be produced by arsenic. There is nothing, however, in the redness caused by this poison, any more than in the redness of inflammation generally, by which it is to be distinguished from the pseudo-morbid varieties. (See p. 122.)

It is singular, that, however severe the inflammation of the inner membrane of the stomach may be, inflammatory redness of the peritonæal coat is seldom found. Yet inflammatory vascularity does occur sometimes on the peritonæal coat. *Sproegel* found it in animals [¶]; and it was present in the case of the girl Warden, whose death gave rise to the trial of Mrs Smith [**]. *Dr*

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[*] Diss. Inaug. Tubingæ, 1808, de Effectibus Arsenici in varios organismos, p. 39.

[†] Diss. Inaug. Edin. 1813, de Venen. Mineralibus, pp. 5, 6, 12.

[‡] Edin. Med. and Surg. Journal, xviii. 171.

[§] London Medical Gazette, xiv. 62.

[‖] Praktisches Handbuch, iii. 232 and 304.

[¶] Dissert. Exp. 36.

[**] Edin. Med. and Surg. Journal, xxvii. 453.

Nissen, a Danish physician, has related another case in which the external coat of the stomach appeared as if minutely injected with wax. But the patient had been attacked with incarcerated hernia during the progress of his illness, and the whole peritonæal membrane was in consequence inflamed *. A common appearance when the internal inflammation is great, and one often unwarily put down as inflammation of the peritonæum, is turgescence of the external veins, sometimes so great as to make the stomach look livid.

Blackness of the villous coat from effusion of altered blood into its texture is sometimes met with. When the colour is brownish-black, or grayish-black, not merely reddish-black, when the inner membrane is elevated into firm knots or ridges by the effusion, and the black spots are surrounded by vascularity or other signs of reaction, the appearances strongly indicate violent irritation. I have already said that I hardly think they are ever imitated by any pseudo-morbid phenomenon.

The next appearance which may be mentioned is unnatural softness of the villous coat of the stomach. This coat has certainly been often found, after death from arsenic, unusually soft, brittle, and easily separable with the nail †. But this state occurs in dead bodies so often and so completely unconnected with previous symptoms of irritation in the stomach, that it cannot with any certainty be assumed as the effect of irritation when it is found subsequently to such symptoms. So far from softening and brittleness being a necessary effect of the irritation produced by arsenic, it is a fact that a state precisely the reverse has often been noticed. In a case which I examined, the villous coat, except where it had been disintegrated by the effusion of blood and by ulceration, was strong and firm, and the rugæ were thickened, raised, and corrugated, as if seared with a hot iron ‡. *Metzger* once found the mucous membrane dense, thickened, and the rugæ like thick chords §. *Pyl* too once met with the same appearance, and ascribes the thickening to gorging of vessels ‖; and in a case related by *Dr Wood* of Dumfries, where I had an opportunity of examining the stomach, this appearance was present in a remarkable degree, and it clearly arose from elevation of the villous coat by effusion of blood under it[*]. *Remer*, in his edition of Metzger's Medical Jurisprudence, says he once met with an instance where the stomach was shrivelled like a bladder after being put into boiling water[†].

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* Nordisches Archiv, i. 334.

† Jaeger, p. 40.

‡ Edin. Med. and Surg. Journal, xxvii. 453.

§ Schlegel, Collect. Opusc. &c. iv. 23.

‖ Aufsätze und Beobachtungen, i. 58.

Sometimes the villous and also more rarely the other coats of the stomach are found actually destroyed and removed in scattered spots and patches. This loss of substance is occasionally owing to the same action which causes softening and brittleness of the villous coat,—the action, however, having been so intense as to cause gelatinization. That such is the nature of the process appears from the breach in the membrane being surrounded by gelatinized tissue and not by an areola of inflammatory redness. Of this species of destruction of the coats I have seen a characteristic example[‡]. But in other cases the loss of substance is owing to a process of ordinary ulceration, as is proved by the little cavities having a notched irregular shape, and being surrounded both by a red areola and a margin of firm tissue. This was the character of the ulcers in the case of Warden, which I have described elewhere[§]. Destruction of the coats of the stomach by ulceration is not a very common consequence of poisoning with arsenic, as death frequently takes place before that process can be established. For the most part it is hardly to be looked for unless the patient survived nearly two days. In many general works on Medical Jurisprudence, and in some express treatises on arsenic, it is stated that this poison may cause complete perforation of the stomach[||]. But this effect is exceedingly rare. I have related one distinct example of it[¶]; *Professor Foderé* has briefly alluded to a case he witnessed which proved fatal in two days and a-half[**]; I have likewise found in an account of a trial in N. America, an instance in which the stomach was perforated by numerous small holes, so that when held before the light it appeared as if riddled like a sieve*; but I have not been able to find in medical authors any farther authority for the general statement. Destruction of the coats of the stomach as produced by arsenic, has been variously described by authors under the terms erosion, corrosion, dissolution, ulceration. But the correct mode of describing it appears to be by the terms gelatinization, or ulceration, according to the nature of the diseased action by which it is induced. At all events it is necessary to beware of being misled by the terms erosion, corrosion, and the like, which all convey the idea of a chemical action, while it is well ascertained that a chemical action either does not exist at all between arsenic and the animal tissues, or, if it has existence, tends to harden and condense rather than to dissolve or corrode them. Arsenic is not a corrosive.

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[*] Edinburgh Med. and Surg. Journal, xxxiii. 66.

[†] Metzger's System der gerichtlichen Arzneikunde, von *Remer*, 1820, p. 257.

[‡] Edin. Med. and Surg. Journal, xxix. 25.

[§] Ibid. xxvii. 453.

[||] *Gmelin's* Geschichte der Mineralischen Gifte, 124. *Foderé*, Médecine-Légale, iv. 127. *Sallin*, Journal Général de Médecine, iv.

[¶] Edin. Med. and Surg. Journal, xxix. 25.

[**] Journal Complémentaire, i. 106.

Another species of destruction of the coats of the stomach, which will require a little notice, is sloughing or Gangrene. This appearance occurs frequently in the narratives of the older writers; but it has not been enumerated in the list of morbid appearances at the commencement of this section, because its existence as one of the effects of arsenic is problematical. It has not been witnessed so far as I know in any recent case, or by any late authority. Those who have mentioned it have probably been misled by the appearance put on by the black extravasated patches, when they are accompanied by disintegration of the villous coat and effusion of clots of black blood on its surface,—an appearance which resembles gangrene closely in every thing but the fetor. *Mr Brodie* has stated that Mr John Hunter has preserved in his museum as an example of a slough of the villous coat caused by arsenic what turned out on examination to be nothing else than an adhering clot†.

Various secretions have been found on the inner surface of the stomach. The mucous secretion of the inner membrane is almost always increased greatly in quantity. Frequently it is thin and glairy as in its natural state; but sometimes it is both abundant and solid, as if coagulated; and then it forms either a uniform attached pellicle, or loose shreds floating among the contents [*]. In both forms it has been mistaken for the mucous membrane itself. I believe this increased secretion and preternatural firmness of the gastric mucus cannot take place without some irritating agent being applied to the stomach. Both may occur without any other sign of inflammation in the mucous membrane.—Sometimes, however, the matter effused is true coagulable lymph. This is rarely seen as the effect of arsenic. I have remarked it, however, very distinctly in dogs, and *Dr Baillie* saw it once in the human subject [†]. It is of course quite decisive of the presence of inflammation. It is known from tough mucus, to which it bears some resemblance, by its reticulated disposition and by the threads of the reticulation corresponding with inflamed lines on the stomach beneath.

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* Trial of Medad Mackay at Allegany, 1821. The prisoner was found not guilty. But the presence of arsenic in the stomach was proved by several tests.

† Philosophical Transactions, cii. 216.

Another and a very common appearance is the presence of a sanguinolent fluid, or even of actual blood in the cavity of the stomach. In several of the cases which have come under my own notice, the subject of analysis was a thick, dirty brownish-red fluid, evidently containing a large proportion of blood; and many other cases of the same nature are on record [‡]. In *Laborde's* case formerly mentioned actual clots were found among the contents; in the instance of a woman who died in five days, as related by *Zittmann*, half a pound of coagulated blood was found in the stomach [§]; and in another case mentioned by *Professor Bernt* the stomach contained no less than three pounds of black ichor mixed with clots of blood [‖]. A good deal of reliance has been placed on bloody effusion in proof of the administration of arsenic or some other active irritant. It is of some importance, as it appears not to be an effect of that irritation which causes cholera.

Among the appearances observed in the stomach the presence of arsenic may be included, though not properly speaking a morbid appearance. Under the head of the medical evidence of poisoning generally it was stated, that many causes conspire to remove from the stomach during life poisons which have actually caused death. In the instance of arsenic, however, their

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[*] *Harles* de Arsenico, 153, and *Renault* sur les Contrepoisons de l'Arsenic.

[†] Morbid Anatomy, p. 128.

[‡] *Metzger* in Schlegel's Opuscula, iv. 23. *Pyl's* Aufs. und Beob. i. 60. *Platner*, Quæstiones Medicinæ Forenses, 206.

[§] Medicina Forensis Cent. v. Cas. 45. quoted by *Wibmer*.

[‖] Beiträge zur gerichtlichen Arzneikunde, iv. 221.

whose death gave rise to the trial of John Lovie held at Aberdeen in the Autumn Circuit of 1827, and lastly in the case described by *Dr Wood*, which I had an opportunity of examining [*]. In all the oxide was found, as well as the sulphuret of arsenic, and in the last but one sulphuretted-hydrogen formed part of the gases of the stomach [†]. In the case related by *Dr Nissen*, [p. 312], the same yellow appearance was observed on the surface of the arsenic, and was ascribed with justice to the action of sulphuretted hydrogen-water, which had been given as an antidote during life [‡]. In a very important case lately examined here by my colleague *Dr Traill*, and which will be noticed more particularly for a different purpose afterwards, this conversion of the oxide into sulphuret had taken place to a great extent [326]. In every instance of the kind yet examined, however, the conversion has been but partial, so that a large proportion of oxide could easily be detected by the usual process.

Care must be taken not hastily to consider as arsenic every white powder which may be found lining the inside of the stomach. Many other white powders may obtain entrance from without; and besides, small, white, shining, pulverulent scales, not unlike finely powdered arsenic, but really composed of animal matter, are sometimes formed on the mucous coat of the stomach and intestines, In a medico-legal report published a few years ago, *Professor Orfila* has noticed two instances in which these scales were mistaken for arsenic [§]; in another published not long after he mentions that he found white particles which crackled when bruised, and appeared brilliant before the microscope, and which nevertheless were not arsenic [‖]; *Buchner* too says he is acquainted with an instance where, in a medical inspection on account of a suspicion of poisoning, the villous coat of the stomach was found lined with a white granular substance which presented the properties of a fat and contained no mineral admixture [¶]; and in the case of Warden I remarked a similar appearance, which, as arsenic was found in the stomach, I was disposed to consider a sprinkling of that poison, until the contrary was ascertained by analysis. The present caution, therefore, is not superfluous.

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[*] Edin. Med. and Surg. Journal, xxxiii. 66.

[†] Ibid. xxix. 415, or Syme's Justiciary Reports, i.

[‡] *Pfaff* and *Scheel's* Nordisches Archiv. i. 345.

[§] Archives Génér. de Méd. vii. 1.

[‖] Ibidem, vii. 285.

[¶] Repertorium für die Pharmacie, xxiv. 144.

In a few cases the stomach is the only situation where morbid appearances are visible, even though life has been prolonged for so much as two days. This state of matters is well exemplified by a case in the Archives Générales of death in forty-three hours, where the stomach presented much redness and extravasated patches, but where the intestines, the larynx and the contents of the head and chest were in a natural condition*. Such limitation, however, of the diseased appearances is rare.

Redness of the mucous membrane of the intestines is often present when the stomach is much inflamed. Dissolution of the mucous coat is much less frequent in the intestines than in the stomach. Ulceration occasionally occurs in lingering cases. In the case of Mitchell, which has been several times alluded to, the inner coat of the duodenum was dark-red, pulpy, thickened, easily separable; and on a spot as big as a crown-piece, both the inner and the muscular coats were wanting †.

The signs of inflammation are seldom distinct in the small intestines much lower down than the extremity of the duodenum; and they do not often affect the colon. But it is a curious fact, that the rectum is sometimes much inflamed, though the colon, and more particularly the small intestines are not. Dr Male mentions, that in man he has found the rectum abraded, ulcerated, and even redder than the stomach itself ‡; and *Dr Baillie* also notices two cases in which the lower end of the rectum was ulcerated §. A common appearance in lingering cases is excoriation or ulceration of the anus ||, and in some cases it is said that even gangrene has been produced ¶.

A late writer draws the attention of toxicologists to the fact that in the only two fatal cases he had seen of poisoning with arsenic the whole course of the colon was contracted to an extraordinary degree **; and I find this state mentioned in several cases published previously. The appearance deserves no-

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* Archives Gén. de Méd. ii. 58.

† Edin. Med. and Surg. Journal, xviii. 171.

‡ Elements of Juridical Medicine, 76.

§ Morbid Anatomy, p. 128.

|| Case of Mr Blandy, State Trials, xviii.

¶ Bachmann's Essay, (see p. 305.)

** *Houlton* in London Med. Gazette, xiv. 712.

tice. It admits of an obvious explanation; but of course whatever empties the colon as thoroughly will have the same effect.

The chief appearances in the alimentary canal have now been mentioned. The next quarter in which diseased appearances are to be met with is the cavity of the chest. Here are sometimes seen redness of the pleura, redness and congestion of the lungs, redness of the inner surface of the heart, and redness of the lining membrane of the windpipe.

Redness of the diaphragmatic part of the pleura, or even of the whole of that membrane, has been at times observed; as one would expect, indeed, from the pectoral symptoms which occasionally manifest themselves during life. Inflammation of the lungs themselves has also been noticed. *Dr Campbell* twice found great congestion of blood in the lungs of animals poisoned by the application of arsenic outwardly *. *Sproegel* likewise found the pleura, pericardium, and whole lungs deeply inflamed in animals †. *Dr Venables* found the pleura of a bright crimson colour in some poultry maliciously poisoned with arsenic, —more redness there indeed than in the stomach ‡. A distinct example of advanced peripneumony in man is related in *Pyl's* new Magazine: The patient died after vomiting and purging incessantly for eight days; and on dissection the lungs were found " in the highest state of inflammation, and so congested as to resemble a lump of clotted blood §." A very good case of the same nature is related in *Henke's* Journal: this patient had obvious peripneumonic symptoms during life; and in the dead body the lungs were found so gorged, that on being cut into nothing could be seen but clotted blood in their cellular structure ||." In a case formerly adverted to [298] of death from arsenic applied externally for scirrhus excessive congestion was found in the lungs, " both lungs being completely gorged with blood, and presenting all the characters of pulmonary apoplexy ¶." In another described by *Dr Booth* of Birmingham where death occurred in seven hours only the lungs presented sufficient congestion to have completely impeded respiration **.

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* Diss. Inaug. Edin. 1813, pp. 11 and 12.

† Diss. in Haller's Disp. de Morbis, vi. Exp. xxxvi.

‡ London Med. Gazette, x. 115.

§ Neues Magazin, I. iii. 508.

|| Zeitschrift für die Staatsarzneikunde, i. 32.

¶ Annales d'Hyg. Publique, xi. 461.

** London Med. Gazette, xiv. 62.

It has been stated that the inner surface of the heart has been found red from inflammation. In a case examined judicially at Paris by *Orfila*, the left cavities of the heart were of a mottled red hue, and in the ventricle were seen many small crimson specks which penetrated into the muscular part of the parietes. The right cavities had a deep reddish-black tint, and the ventricle of that side contained specks like those in the other, but more faint. Orfila adds, that he had previously seen the same appearance in animals [*]. These observations are not quite satisfactory. There is no evidence that the observer drew the distinction between the redness of inflammation, and that produced by the dyeing of the membrane with the blood after death. The subject was lately brought before the Royal Academy of Medicine at Paris by *M. Godard*, who had also observed the appearance in question in a person killed by arsenic, and who dwelt strongly on it as characteristic of this species of poisoning. It was distinctly proved, however, by many members present that the appearance arises from many other causes [†].

The inner membrane of the windpipe is said to be sometimes affected with inflammatory redness. *Jaeger* found it so in animals [‡]; and the symptoms referrible to the windpipe during life would lead us to expect the same thing in man.

The organs of generation are occasionally affected. The penis in the male and the labia in the female have been found distended and black; in the interesting case related by Bachmann the external parts of generation (in a female) were surrounded by gangrene [§]; and in a case related in Pyl's collection the inside of the uterus and Fallopian tubes was inflamed [‖]. It is probable that signs of inflammation in the internal organs of generation will be found in those cases in which there have been corresponding symptoms during life. But in truth this part of the pathology of poisoning with arsenic has not been particularly attended to.

To complete this account of the morbid appearances of the mucous membranes, it may added that the conjunctiva of the eyes frequently presents vascularity and spots of extravasation [*].

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[*] Archives Générales, i. 147.

[†] Nouvelle Bibliothèque Médicale, 1829, i. 395.

[‡] Jaeger, de Effectibus Arsenici, p. 40.

[§] Bachmann's Essay, p. 41, or above, p. 305.

[‖] Aufsätze und Beobachtungen, i. 50.

It now only remains, under the head of the morbid appearances produced by arsenic, to mention certain alterations that are said to take place in the state of the blood and general condition of the body.

With regard to the state of the blood *Mr Brodie* observes in general terms, that in animals killed by arsenic it is commonly fluid [†]; and *Harles*, on the authority of Wepfer, Sproegel, and Jaeger, says it is black, semigelatinous, and sometimes pultaceous [‡] In a fatal case related by *Wildberg* the blood was everywhere fluid [§]. This condition, however, is not uniform; for *Dr Campbell* found the blood coagulated in the heart of a rabbit [‖]; and *Wepfer* found it also coagulated in the dog [¶].

It has been stated by some authors in medical jurisprudence that the dead body occasionally exhales an alliaceous odour resembling that of sublimed arsenic. This is a very questionable statement. The only fact of the kind worth mentioning is one brought forward by *Dr Klanck*, as occurring in the course of certain experiments, which will presently be noticed, on the antiseptic virtues of arsenic. Several animals which had been killed with arsenic are said to have exhaled an odour like that of sublimed arsenic from three to eight weeks after death [**].

A great discordance of opinion and statements has prevailed among authors, as to the influence of arsenic on the putrefactive process in the bodies of those poisoned with it. The vulgar idea, borrowed probably from the ancient classics, that the bodies of those who have been poisoned decay rapidly, was till lately the prevalent doctrine of medical men, and even of medical jurists; and it was applied to arsenic as well as other poisons. Even so lately as 1776 we find *Gmelin* stating in his History of Mineral Poisons, that the bodies of those who have died of arsenic pass rapidly into putrefaction, that the nails and hair often fall off the day after death, and that almost the whole body quickly liquefies into a pulp[*]. Nay, a similar statement has been made in 1795 by a respectable author *Dr John Johnstone* [†]. It certainly appears that this rapid or premature decay does really occur in some instances. Thus in a case related by *Plattner* of death from arsenic administered as a seasoning for mushrooms, the body had a very putrid odour the day after death [‡]. *Loebel* also asserts he found by experiments on animals, that after death from arsenic putrefaction took place rapidly, even in very cold weather [§].

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[*] Wibmer. Die Wirkung der Arzneimittel und Gifte, i. 281, 283.

[†] Phil. Trans, cii. 214.

[‡] De Arsenici usu in Medicina, 1811, p. 154.

[§] Practisches Handbuch, iii. 229.

[‖] De Venenis Mineralibus. Diss. Inaug, Edinburgi, 1813.

[¶] Historia Cicutæ, 288.

[**] Augustin's Repertorium. Neue Entdeckungen betreffend die Kennzeichen der Arsenic-vergiftung, I. i. 30.

In other instances the body probably decays in the usual manner. For example, in Rust's Magazin is related the case of a child who died in six hours of poisoning with arsenic, and in whose body, fourteen days after death, the integuments were found considerably advanced in putrefaction, and the liver and kidneys beginning to soften [||]. And in the course of some experiments on dogs poisoned with the oxide *Dr Seeman* found the usual changes after five months' interment [¶].

But of late it has been suspected that in general arsenic has rather the contrary tendency,—that, besides the antiseptic virtues which it has been long known to possess when directly applied in moderate quantity to animal substances, it also possesses the singular property of enabling the bodies of men and animals poisoned with it both to resist decay unusually long, and to decay in an unusual manner. The observations and inquiries which have been made abroad on this subject were little known any where else than in Germany before the publication of the earlier editions of this work; but parallel examples have been very recently met with both in Britain and France; and in this country the importance of the subject is generally appreciated.

The first occasion on which the antiseptic property of arsenic was brought under public notice was about the beginning of the present century, in the course of the trial of the widow of a certain state-councillor, Ursinus of Berlin. Some time before that *Dr Welper*, then medical inspector in the Prussian capital, having remarked that the body of a person poisoned with arsenic remained quite fresh for a whole week in summer, he attended carefully to the subject at every opportunity, and invariably, he says, found that the body resisted putrefaction. Not long after making this remark, he was concerned in 1803, by virtue of his office, in the investigations in the case of the widow Ursinus. This lady having been discovered in an attempt to poison her servant, suspicions arose regarding the previous sudden death of three persons in her family, her husband, a young officer who had carried on an amour with her, and an aunt from whom she derived an inheritance. They had all died in mysterious circumstances, and the lady had been their only nurse. Dr Welper disinterred the bodies of the husband and aunt, which had been buried, the former two years and a-half before at Berlin, the latter half a year afterwards at Charlottenberg; and he found them not putrid, but dried up; and specks of an appearance, which is described as being gangrene, but which was probably warty extravasation, were visible in the stomach. Arsenic could not be detected.

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[*] Geschichte der Mineralischen Gifte.

[†] Essay on Mineral Poisons, 36.

[‡] Quæst. Medicinæ Forenses, 206.

[§] *Jaeger*, de Effectibus Arsenici, p. 47.

[||] Magazin für die gesammte Heilkunde, xx. 485.

[¶] Geiger's Magazin für Pharmacie, xxxii. 301. from Seeman's Dissert. Inaug. Berolini, 1824.

He afterwards got *Dr Klanck*, his acquaintance, to make some express experiments on animals; and the results were strikingly conformable. In dogs poisoned with arsenic and left for two months sometimes buried in a damp cellar, sometimes exposed to the air of the cellar, the flesh and alimentary canal were found red and fresh, as if pickled; and though the place where the carcases were subsequently buried again was flooded for eight months after, the intestines were eventually found entire and red, the fat converted into adipocire, and most of the muscles unaltered,—those only being soft and greasy which were directly acted on by the water. From a set of comparative experiments which were made on dogs killed by blows, or poisoned by corrosive sublimate, or by opium, Klanck found, that, after being buried in the same place, and for the same space of time, the whole soft parts of the carcases were converted into a greasy mass. In a subsequent year he repeated his experiments, the bodies, however, being this time left exposed to the air of the cellar. The experiments were commenced in the month of August. In ten days there appeared slight signs of incipient putrefaction; a faint putrid smell was exhaled, and all flies that settled on the carcases died. This state continued for eight or ten weeks without increasing. After that the soft parts began to grow firmer and drier, and at the same time the putrid odour was succeeded by a smell like that of garlick, which became insupportably strong when the carcases were removed into the warm air. The bodies, three years afterwards, still continued dry and undecayed [*].

A similar set of facts was again brought before the public between 1809 and 1811, during the criminal proceedings in a case like that of the widow Ursinus, tried first at Bayreuth and afterwards by appeal at Munich. A lady near Bayreuth died of five days' illness, under symptoms of violent general irritation of the alimentary canal. Some months afterwards a variety of circumstances having raised a suspicion that she had been poisoned by her maid, Margaretha Zwanziger, a judicial investigation was set on foot, the consequence of which was, that the same woman came under suspicion of having also previously poisoned another lady and a gentleman with whom she had been successively in service. The bodies of the three people were accordingly disinterred, one of them five months, another six months, and the third fourteen months after death. In all of them the external parts were not properly speaking putrid, but hard, cheesy, or adipocirous; in the two last the stomach and intestines were so entire as to allow of their being tied, taken out, cut up, and handled; and in one a sloughy spot was found in the region of the pylorus. Arsenic was detected in two of the bodies by Rose's process of analysis [†].

The next example to the same effect which will be mentioned is perhaps the most satisfactory of all, because it was the result of an express experiment on the human subject. *Dr Kelch* of Königsberg buried the internal organs of a man who had died of arsenic, and whose body had remained without burial till the external parts had begun to decay; and on examining the stomach and intestines five months after, he found that the hamper in which they were contained was very rotten; but that "they had a peculiar smell, quite different from that of putrid bowels, were not yet acted on by putrefaction, but as fresh as when first taken from the body, and might have served to make preparations. They had lost nothing of their colour, glimmer, or firmness. The inflamed spots on the stomach had not disappeared; and the small intestines also showed in some places the inflammatory redness unaltered *."

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[*] For an excellent analysis of the case of Ursinus and the experiments of Klanck, see *Augustin—Neue Entdeckungen betreffend die Kennzeichen der Arsenic-vergiftung, und Berichtigung älterer Angaben über diesen Gegenstand,*—in *Augustin's Repertorium*, I. i. 36.

[†] *Bachmann*, Einige auserlesene gerichtlich-medizinische abhandlungen, von Schmidt, Bachmann, and Küttlinger. Nürnberg, 1813.

In a recent French case, although the degree of preservation was less remarkable, the other circumstances are so striking as to render it well worthy of notice. In this instance the body was disinterred after having been seven years in the ground, in a high situation and sandy soil. The coffin, which was of oak, had become dry and brittle, and no moisture appeared on the inside. The body was entire; the head, trunk, and limbs retained their situation; but the organs of the chest and belly were converted into a brown soft mass of the consistence of plaster, which lay on each side of the spine. In this mass *MM. Ozanam* and *Idt*, the medical inspectors, succeeded in discovering by chemical analysis a considerable quantity of arsenic †.

In the case of the girl Warden, which has been several times alluded to, [p. 279], the internal organs were also preserved somewhat in the same manner as in the German cases. The body had been buried three weeks; yet the mucous coat of the stomach and intestines, except on its mere surface, was very firm, and all the morbid appearances were consequently quite distinct. Nay, three weeks after disinterment, except that the vascularity had disappeared, the membranes and the appearances in them remained in the same state ‡. A similar case has been recorded by *Metzger*. It is that of an old man who died of six hours' illness, and in whose stomach three drachms of arsenic were found. The body had been kept ten days in February before burial, and was disinterred eight days after that; yet there was not the slightest sign of putrefaction any where §. A parallel case was described by myself in the Edinburgh Medico-Chirurgical Transactions ‖.

In a very important case, that of Mrs Smith, which was made the subject of investigation at Bristol in December 1834, the body was also found in a state of great preservation, modified, however, by the adipocirous decomposition, owing to the presence of water in the coffin. The body had been fourteen months interred. The internal parts, especially of the head and neck, were here and there decayed somewhat or converted into adipocire, the muscles and internal organs entire, though more or less shrivelled, the alimentary tube remarkably preserved, " every part being almost as distinct as if the inspection had been made at a very short period after death," " the mucous membrane sufficiently tenacious to be lifted by the forceps in as large flakes as usual;" and the reporters, Drs Riley and Symonds, Messrs Herapath and Kelson, seem to have had no difficulty in ascertaining the absence of vascularity, extravasation, or even abrasion of the inner membrane. Artificial orpiment, the preparation proved to have been given, [see p. 268], was found in the stomach by Mr Herapath, and the quantity appeared to be about half a drachm *.

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* Hufeland's Journal, xix. iv. 11, and xxii. i. 166.

† Archives Gén. de Méd. xxi. 615, or Revue Médicale, 1830. i. 165.

‡ Edin. Med. and Surg. Journal, xxvii. 457.

§ *De veneficio caute dijudicando*, in Schlegel's *Opuscula*, iv. 23.

‖ Edin. Med. Chir.-Trans. ii. 284.

A similar instance, also very remarkable in its whole circumstances, was lately investigated here by my colleague *Dr Traill*, to whom I am indebted for the particulars. The master of a foreign vessel died in about twenty-four hours, apparently of malignant cholera, at a small port in the neighbourhood of Edinburgh; and the body was forthwith buried. A suspicion, however, having arisen in his native country that he had been poisoned by his mate, an inquiry was instituted at the request of the foreign government; and the body was disinterred five months after death. The face and neck were swollen, black, and decayed; but the rest of the body was quite free of the usual signs of putrefaction. The skin was white and firm, the muscles fresh, the lungs crepitating, the liver and spleen much shrivelled, the stomach and intestines entire throughout their whole tissues, and capable of being handled freely without injury. On the mucous coat of the stomach several dark patches of extravasation were found, likewise several spots and large patches presenting on their surface a firmly adhering bright-yellow crust; and the contents of the stomach consisted of a considerable quantity of yellow sandy matter of the consistence of paste. The contents and adhering crusts were found to consist chiefly of oxide of arsenic partially converted into sulphuret. In this instance, as in that last described, the coffin contained water, owing to its having lain in a sandy soil resting on clay.

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* Dr Symonds' Account of the Examination, &c. Trans. of Provincial Med. and Surg. Association, iii. 432.

It may be added that the experiments of *Klanck* on dogs adverted to above have been more recently repeated by *Hünefeld* on rabbits and mice, with precisely the same results. The animals were sometimes left in the air, at other times buried, and generally in a moist place. In every instance putrefaction made more or less progress at first; but in a few days a peculiar garlicky odour arose, from which time the progress of decay seemed to be arrested; and the bodies underwent a process of hardening and desiccation which completely preserved them *.

On considering attentively the illustrations now given the toxicologist can hardly doubt that in some cases arsenic has appeared both to retard and to modify putrefaction in the bodies of persons poisoned with it.

Assuming arsenic to have been the cause of the preservation of the bodies, it becomes a point of consequence to account for its effect, and more particularly to reconcile that effect with what has certainly been noticed in other cases of poisoning with arsenic, namely, ordinary rapidity of decay, if not actually an increased tendency to putrefaction.

At the outset of this part of the inquiry some light may be thrown upon it by separating the local from the general operation of arsenic.

Arsenic is a good preservative of animal textures when it is directly applied to them in sufficient quantity. This is well known to stuffers of birds and beasts, was experimentally ascertained by Guyton Morveau †, and has come also under my own observation. I have kept a bit of an ox's stomach four years in a solution of arsenic, and, except slight shrivelling and whitening, I could not observe any change produced in it.

Hence, if in a case of poisoning the arsenic be not discharged by vomiting, and the patient die soon, it will act as an antiseptic on the stomach at least, perhaps on the intestines also; while the rest of the body may decay in the usual manner. This is very well shown in a case examined by *Dr Borges*, medical inspector at Minden, fourteen weeks after death. The stomach and intestines were firm, of a grayish-white colour, and contained evident crumbs of bread, while all the other organs in the belly were pulpy, and the external parts adipocirous [*]. It is also equally well exemplified in a case that happened at Chemnitz so early as 1726, and which was examined five weeks after burial. The skin was every where very putrid, but the stomach and intestines were perfectly fresh [†]. In the case of Warden the appearances were precisely the same. Three weeks after burial the Dundee inspectors found the external parts much decayed, yet three weeks later the stomach and intestines were found by myself in a state of almost perfect preservation. A striking experiment performed by *Dr Borges* on a rabbit will likewise illustrate clearly the fact now under consideration. The rabbit was killed in less than a day with ten grains of arsenic, and its body was buried for thirteen months in a moist place under the eaves of a house. At the end of this period it was found, that " the skin, muscles, cellular tissue, ligaments, and all the viscera, except the alimentary canal, had disappeared, without leaving a trace; but the alimentary canal from the throat to the anus, along with the hair and the bare bones, was quite entire *(fand sich völlig unversehrt vor* [‡]*.")*

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* Dissertatio de vera Chemiæ Organicæ notione, additis experimentis de vi Arsenici in corpore organico mortuo. 1822. Quoted fully by *Wibmer*, die Wirkung der Arzneimittel und Gifte, i. 312.

† Elemens de Chymie, ii. 343.

In all of these cases arsenic was found in the body. In the rabbit experimented on by Dr Borges, above five grains of arsenic were separated in the form of a metallic sublimate.

But, on the contrary, if the arsenic is all or nearly all discharged by vomiting, not only the body generally, but likewise even the stomach and intestines, may follow the usual course of decay. Accordingly, in the case of the child formerly quoted [322], where the body putrified in the usual manner, only four grains and a-half of arsenic had been taken; and as it was swallowed in a state of solution and caused violent vomiting, it must have been almost all ejected. Nay, in such circumstances, the alimentary canal, in consequence of its unnatural supply of moisture and incipient disorganization, may decay somewhat faster than other parts. Thus *Dr Murray* observed in the case of a man formerly mentioned (311), who lived under violent gastric symptoms for seven days, and vomited much, that the stomach, which was removed for more minute examination, decayed so rapidly, that in twenty-four hours an examination was impracticable, while the body in general rather resisted putrefaction *.

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[*] *Kopp's* Jahrbuch, ii. 226.

[†] *Bernt's* Beiträge zur gerichtlichen Arzneikunde, iv. 219.

[‡] Ueber eine Vergiftung durch weissen Arsenic—*Rust's* Magazin für die gesammte Heilkunde, v. 61.

The preceding statements on the differences in the state of preservation of the body after poisoning with arsenic are not then incapable of some explanation. Nevertheless, it must be granted that the reasons assigned will not account for all the apparent cases of the preservative powers of arsenic. And especially they will not explain how the whole body has sometimes resisted decay altogether, and become as it were mummified. It is impossible to ascribe this preservation to the antiseptic power of the arsenic diffused throughout the body in the blood; the quantity there, as was formerly seen, being almost inappreciably small. Consequently, if the preservation of the bodies is not occasioned by some accidental collateral cause, (a mode of accounting for the phenomena which is hardly admissible,) this property of arsenic must depend on its causing by some operation on the living body a different disposition and affinity among the ultimate elements of organized matter, and so altering the operation of physical laws on it. There appears no sound reason for rejecting this supposition, especially as it is necessary to admit an analogous change of affinities as the only mode of accounting for a still more incomprehensible though better established violation of the ordinary laws of nature,—the spontaneous combustion, or more properly speaking the preternatural combustibility of the human body.

The following judicious observations by *Harles* on this subject are worthy of attention:—" In regard," says he, " to this singular property of arsenic, now no longer doubtful, it should be remembered that certain circumstances will limit or impair it, while others will favour or increase it;—circumstances, for example, connected with the soil of the burying-ground, or the air of the vaults where the bodies are deposited. Different soils and different conditions of the air will materially affect the decomposition of all bodies indiscriminately, and will therefore affect likewise the antiseptic properties of arsenic. For it would be absurd to ascribe to arsenic the power of preventing putrefaction in all circumstances whatsoever,—a power which those who make use of it for preserving skins know very well it does not possess, and a power possessed by no antiseptic whatever, not even by alcohol *."

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* Edin. Med. and Surg. Journal, xviii. 172.

Whatever credit is given to the opinion of the German medical jurists in favour of the preservative power of arsenic, the English medical jurist will not lose sight of the fact, that in many instances the body in this kind of poisoning has been found long after death in so perfect a state as to admit of an accurate medico-legal inspection and a successful chemical analysis. In one of his cases Dr Bachmann detected arsenic in the stomach fourteen months after interment; Dr Borges had no difficulty in detecting it in an animal after thirteen months; Mr Herapath discovered it after fourteen months in the human body; and MM. Ozanam and Idt found it after the long interval of seven years.—The late experiments of *Orfila* and *Lesueur* confirm the fact that arsenic may remain long in contact with decaying animal matter, and yet continue in such a state as to be easily detected †. It might be supposed that the poison would pass off partly in the gaseous state by being converted into arseniuretted-hydrogen, partly in the liquid state by becoming arsenite of ammonia, a very soluble compound. But the fact nevertheless is, that notwithstanding these reasons for its disappearance, it may be detected after the lapse of several years.

Under the head of the diseased appearances left by arsenic in the dead body, every change of structure has now been described which has been mentioned by authors and supported by trust-worthy statements. Another set of appearances, however, may still be noticed; but they are here separated from the rest, because the author who notices them has not hitherto been supported in the statement by any special facts of his own, or by the observations of others. In an elaborate essay on a case of poisoning by *Professor Seiler* of Wittemberg, it is said in general terms that arsenic may cause gorging of the vessels of the brain, effusion of serum into the ventricles, inflammation of the brain, and even extravasation of blood[*]. I have not seen any confirmation of this remark in the records of medical jurisprudence, except in regard to turgescence of vessels, which is several times mentioned, and which I have myself witnessed.

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* De usu Arsenici, 164.

† Revue Médicale, 1828, ii. 470.

It is quite unnecessary to notice lividity of the skin among the signs of poisoning with arsenic, except for the mere purpose of reminding the medical jurist, that, although it has been sometimes much relied on as a sign of death from arsenic, it is not of the slightest importance as a sign either of that or of any other kind of poisoning. (See p. 51.)

A few remarks will now be required relative to the action of arsenic on the alimentary canal after death. The object of these remarks is to prepare the medical inspector for investigating attempts to impute the crime of poisoning to innocent persons, by introducing arsenic into the dead body. Such attempts, according to Orfila, have been made; but I am not acquainted with any actual instance.

The action of arsenic on dead intestine has been fully examined by the last mentioned author. If it is introduced into the anus immediately after death, and allowed to remain there twenty-four hours, the mucous membrane in contact with it becomes of a lively red colour, with darker interspersed patches as if from extravasation. The other coats are natural; and so is the mucous membrane itself wherever the poison does not actually touch it. Consequently the margin of the coloration is abrupt and well-defined. When the arsenic is not introduced till twenty-four hours after death, the part to which it is actually applied presents dark patches, while the rest of the membrane is quite healthy[†].

The appearance of redness in the former case is probably the result of lingering vitality. The cause of the dark appearance in the latter it is not easy to comprehend.

When arsenic has been applied during life, the redness, if it has had time to begin at all, extends to some distance from the points with which the poison has been in contact, and passes by degrees into the healthy colour of the surrounding membrane.

On reviewing what has been said of the pathological appearances caused by arsenic, it must appear that the medical jurist can never be supplied from this source alone with satisfactory evidence of the cause of death. But in some circumstances the evidence may amount to a strong probability of one variety or another of irritant poisoning. Mere redness, conjoined or not with softening of the mucous membrane, may justify suspicion only. But if there should be found in the body of a person who has died of a few days' illness, redness, black warty extravasation, and circumscribed ulcers of the villous coat of the stomach,—effusion of blood or bloody clots among the contents of that organ,—redness of the intestines, more especially redness and ulceration of the colon and rectum, and redness of the pharynx, or of this along with the gullet; the proof of poisoning with some irritant will amount to a strong presumption. At least it is difficult to mention any natural disease which could produce in so short a time such a conjunction of appearances as are produced by arsenic and other analogous poisons.

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[*] *Knape und Hecker's* Kritische Jahrbücher, ii. 76.

[†] Toxicologie Générale, ii.

SECTION IV.—*Of the Treatment of Poisoning with Arsenic.*

It was formerly proved that arsenic acts in all its forms of chemical combination, which have been hitherto tried, and nearly in the ratio of their solubility. This general fact is conformable with the law laid down as to the influence of chemical changes on the energy of poisons which enter the blood (p. 32). We are therefore prepared to expect that every supposed chemical antidote will prove useless, which does not render the arsenic insoluble not only in water, but likewise in the contents and secretions of the stomach. Now no compound of the kind is known which can be formed by the action of other substances on oxide of arsenic in the stomach. The arsenites, which are insoluble in water, are all so soluble in the juices of the stomach as to allow of the introduction of a sufficient quantity of the poison into the blood to prove fatal. Hence the absolute inutility of vinegar, sugar, butter, and other oily substances, lime-water, bitter decoctions, and many other antidotes once vaunted, and now justly forgotten.

The sulphuret of potass or liver of sulphur maintained its place for some time at the head of the list. But the experiments of *Renault* on the counter-poisons of arsenic, with the later researches of *Orfila*, have shown satisfactorily, that the arsenical sulphuret formed by solutions of the liver of sulphu nearly as dangerous as the oxide of arsenic itself. *Ren* found, indeed, that a solution of sulphuretted-hydrogen gas paired the activity of a solution of the oxide; but its poison agency was by no means destroyed altogether, obviously bec the sulphuret formed is not insoluble in the gastric fluids. phuretted-hydrogen water given along with the oxide in its lid state had no effect whatever, because the gas acts on the lid oxide very slowly *.

Another antidote which has been more recently propo but without sufficient proof of its beneficial effects, is magne *Mr Hume*, the chemist of London who suggested the use of ammoniacal nitrate of silver as a test for arsenic, says he cured a dangerous case with repeated large doses of magnesi Since the publication of his statement, *Mr Buchanan* has c firmed it by the particulars of another successful case treate like manner ‡: and *Mr Edwards* has added another, in wh however, blood-letting was also freely employed §. It is d cult to see how this inert substance, which does not act ch cally on oxide of arsenic, and has little action itself on the mal economy, should prove an antidote; and it is therefore bable that collateral circumstances contributed mainly to cure. Mr Buchanan's case in particular is far from suppl satisfactory evidence of the virtues of magnesia. The pati indeed, took no less than an ounce of the oxide and retain half an hour in his stomach. But he took it along with a l quantity of milk, the coagulation of which would preven diffusion over the surface of the stomach; and profuse rep vomiting was induced at an early period by sulphate of zin consequence of which the powder of arsenic had completely appeared from the discharges before the magnesia was gi It is right to add that in less than a day his patient was fr complaint.

Another antidote worthy of being specified is charcoal. *Bertrand* inferred from some experiments on animals, powder of charcoal is a useful antidote; and was so convinced of its efficacy that he himself swallowed at once five grains of arsenic in a charcoal emulsion. He experienced a sensation of warmth in the epigastrium and considerable thirst, but no other bad consequence resulted, although he did not vomit[*]. The same remarks apply to this substance as to magnesia. Being an inert substance, totally destitute of chemical action on arsenic, it cannot materially impair the operation of the poison on the economy; and accordingly, as was formerly stated (p. 269), *Orfila*, who has examined the pretensions of this antidote at great length, found it to have no sensible power in preventing the action of arsenic on animals[†].

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* Sur les Contrepoisons de l'Arsenic, pp. 33, 35.

† London Med. and Phys. Journal, xlvi. 466 and 545. This remedy w posed in 1808 by *M. Mandel*, as may be seen from a paper in the *Annal Soc. de Méd. de Montpellier*, xvii. Histoire de la Soc. v. 7.

‡ London Med. Repository, xix. 288.

§ London Med. and Phys. Journal, xlix. 117.

The only other antidote deserving particular notice is one which has made no little noise of late,—the hydrated peroxide of iron. This was announced by *MM. Bunsen* and *Berthold* of Göttingen as an effectual remedy even when given some time after the arsenic is swallowed. Their experiments have been repeated by others with variable results. *MM. Soubeiran* and *Miquel*, as well as *MM. Orfila* and *Lesueur*, have obtained results somewhat similar from experiments on dogs; and *M. Bouley* has arrived at similar conclusions in repeating their experiments on the horse. The latter found that the effects of an otherwise fatal dose of arsenic are almost entirely prevented in the horse by giving the peroxide of iron either immediately after the poison or within four hours[‡]. Very opposite results have been obtained in this country. *Mr Brett* of London found that the hydrated oxide of iron has little if any power of uniting with oxide of arsenic even in solution and aided with a boiling heat; —that it will not decompose the arsenite of potass in solution, but that the sulphate of peroxide of iron will;—that the hydrated peroxide of iron given to a rabbit a few minutes after a small dose of arsenic had been administered had no appreciable effect in retarding death;—and that a carefully prepared arsenite of iron in the dose of five or six grains seemed to act nearly as fast as arsenic itself[§]. From these facts, as well as from the circumstance, that Orfila, Bouley, and others have found it necessary to give the oxide in very large proportion to the arsenic so as to obtain any good effect, it seems probable that this substance, like charcoal powder and magnesia, is not a true antidote, but may nevertheless be occasionally of use by enveloping the coarser powder of arsenic with its fine, impalpable, adhesive particles.

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[*] Journal Générale de Médecine, 1813 and 1815, p. 363.

[†] Toxicol. Gén. i. 429.

[‡] Annales d'Hyg. Publ. et de Méd. Lég. xiv. 134.

[§] London Medical Gazette, xv. 220.

So much for the chemical antidotes for arsenic. If no such antidote really has existence, much less are we acquainted with any belonging to the rarer class of counter-poisons which operate by exciting a counter-action in the system.

A good deal, however, may be done by general medical treatment to improve the chance of recovery. If vomiting should be delayed, as often happens, for half an hour or more, advantage ought to be taken of the opportunity to administer an emetic of the sulphate of zinc, with the view of withdrawing the powder in mass before it is diffused over the stomach; and for the same purpose milk should be drunk both before and after vomiting has begun, as it appears to be the best substance for enveloping the powder, and so procuring its discharge. The patient should never be allowed to exhaust his strength in retching, without a little milk or other fluid in his stomach to act on. At the same time, there is probably some justice in the opinion expressed by a late writer on this subject, that large draughts of diluents are injurious; and that, unless the stomach is allowed to contract fully and frequently on itself, it cannot discharge from its surface the mucous secretion, in which the powder of arsenic is in general closely enveloped *. The stomach-pump, although it has been applied to cases of poisoning with arsenic, does not seem to possess any advantage whatever over the natural efforts of nature, if seconded by draughts of liquids, and is probably less effectual in expelling the mucus which envelopes the poison. Even emetics are unnecessary, when vomiting has commenced in consequence of the operation of the poison. When milk in sufficient quantity cannot be procured, strong farinaceous decoctions will probably prove useful.

Supposing the poison to have been removed from the stomach, or that the patient has been put on the course which appears best fitted to accomplish that end,—two indications of cure remain to be fulfilled, namely to allay the inflammation of the alimentary canal, and to support the system under that ex-

* *Mr Kerr* in Edin. Med. and Surg. Journal, xxxvi. 97.

traordinary depression which it undergoes in the generality of cases. Were it not for the latter of these objects the treatment would be both obvious and frequently successful. But it is highly probable that the active remedies, to which the physician trusts in internal inflammations generally, and which are urgently called for by the inflammation caused by arsenic, cannot be enforced with the requisite vigour on account of the remote depressing effects also produced by this poison on the system.

Nevertheless, it is certain that in a few even very aggravated cases the purest and most vigorous antiphlogistic treatment has been resorted to with success. *Dr Roget's* patient, whose case was formerly referred to for another purpose, seems to have been saved by venesection; and at all events, the amelioration effected was unequivocal. In the Medical Repository there is another good example of the beneficial effects of blood-letting carried even to a greater extent than in Roget's case *; and in the Medical and Physical Journal † a third instance will be found, which after the first twenty-four hours assumed the form of pure gastritis, and was treated as such with success. Blood-letting ought not to be practised till the poison is nearly all discharged from the stomach, because it promotes absorption by causing emptiness of the blood-vessels.

It is not probable that any material advantage will be derived from topical blood-letting, at least in the early stage, because if depletion is to be of use at all, it must be carried at once to a far greater extent than it is possible to attain by local evacuants. Blisters on the abdomen will prove useful auxiliaries in the advanced stage.

Opium in repeated doses will without doubt prove useful, when the poison has been removed, and the inflammation subdued by blood-letting. And I conceive that to the form of gastritis, caused by arsenic, may be applied a variety of treatment by anodynes, which has of late been a good deal used in acute inflammation generally,—the free administration of opium immediately after copious depletion. For the safe employment of this method, however, it is essential that the arsenic be completely removed from the stomach and intestines. And from the results of many cases there must always be great reason to apprehend, that, before the treatment can be with propriety resorted to, the patient's strength will be exhausted.

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* Lond. Med. Repository, ix. 456.

† Med. and Phys. Journal, xxix.

The use of laxatives is particularly required in all cases in which there is tenesmus instead of diarrhœa, or where, in the latter stages, diarrhœa is succeeded by constipation; and castor oil is the laxative generally preferred. While diarrhœa is present and the evacuations are profuse or the intestines have been thoroughly emptied, laxatives are unnecessary or even hurtful; but emollient clysters are advisable. When the anodyne system of treatment is resorted to, the opium may be given in the form of enema, or rather as a suppository. In short, so far as regards the intestinal affection, the treatment of the acute stage of dysentery is to be enforced.

Little need be said of the practice to be pursued in the advanced stages of poisoning with arsenic, when convalescence has begun. The principal object is to support the system by mild nourishment, avoiding at the same time stimulant diet of every kind, but especially spirituous and vinous liquors. Whatever may be the difference of results obtained with the antiphlogistic mode of cure, the opposite system has been invariably detrimental.

The treatment of the nervous and dyspeptic affections, which may supervene after the symptoms of local inflammation have ceased, is not a fit object of review in this work, as it would lead to great details.

CHAPTER XIV.

OF POISONING WITH MERCURY.

The next genus of the Metallic Poisons includes the preparations of Mercury. Some of these are hardly less important than the arsenical compounds. They act with equal energy, produce the same violent symptoms, and cause death with the same rapidity. They have therefore been often given with a criminal intent; and have thus become the subject of inquiry upon trials. In another respect, too, they claim the regard of the medical jurist: Their effects on the body, when insidiously introduced in the practice of the arts in which mercury is used, form a branch of that department of medical police, which treats of the influence of trades on the health.

Section I.—*Of the Chemical History and Tests for the preparations of Mercury.*

Mercury is a fluid metal, exceedingly brilliant, of a silver-white colour, and of the specific gravity 13.568.

When heated to about 660° F. it sublimes, and on cooling it condenses unchanged. If this experiment is made in a small glass tube, the metal forms a white ring of brilliant globules, which may be made to coalesce into a single large one. In this way its physical properties may be recognized, though the quantity is exceedingly minute.

Two oxides of this metal, a protoxide and peroxide, exist in combination with acids. A bluish-gray or grayish-black powder is separated from the salts of the protoxide by the fixed alkalis. But many chemists regard this as a mere mixture of metallic mercury with the peroxide. The peroxide has an orange-red colour, and is the common red precipitate of the apothecary. Mercury unites with sulphur in two proportions. The protosulphuret, which is black, is formed from the salts of the protoxide by the action of sulphuretted-hydrogen: The bisulphuret is the well-known pigment, cinnabar or vermilion. Mercury likewise unites with chlorine in two proportions, forming an insoluble protochloride and a soluble bichloride, the former calomel, the latter corrosive sublimate. It likewise unites with cyanogen. Mercury also unites in the state of protoxide and peroxide with the acids. Several compound salts are known to the chemist, but few occur in commerce or the arts.

Among the compounds resulting from the action of this metal with other substances, those which require notice in a toxicological treatise are the following:—1. The peroxide or *Red Precipitate;* 2. The bisulphuret or *Vermilion;* 3. The protochloride or *Calomel;* 4. The bichloride or *Corrosive Sublimate;* 5. The sub-bisulphate or *Turbith Mineral;* 6. The *Cyanide* or Prussiate of Mercury; and 7. The Nitrates of Mercury. Its other compounds are of little consequence to the toxicologist.

1. *Of Red Precipitate.*

Red Precipitate, when well prepared, is in the form of small, brilliant, heavy scales of a scarlet or orange colour. It consists of 100 mercury and 8 oxygen. It is insoluble in water.

It is easily distinguished from all other substances by the action of heat. If a little of it is heated in a small glass tube, metallic globules are sublimed, and oxygen gas is disengaged. The escape of oxygen may be ascertained by plunging to the bottom a small bit of burning wood, when the combustion will be observed to be enlivened.

2. *Of Cinnabar.*

Cinnabar or Vermilion, the bisulphuret of mercury, usually exists in the arts in the form of a fine, heavy, red powder, of a peculiar tint, which is termed from this substance vermilion-red, In mass its structure is coarsely-fibrous, and its colour reddish-brown; and it has some lustre. When thrown down from a solution of corrosive sublimate by sulphuretted-hydrogen, or the alkaline hydrosulphates, it forms a black powder, which acquires a red tint by being sublimed. It is composed of 100 metal and 16 sulphur.

It is distinguished from other substances by the operation of heat, and by the effects of reduction with potass. Heated alone in a tube it sublimes without change. Its colour, indeed, which is fugacious under heat unless particular manipulations are used, becomes darker and dingy; but its lustre and crystalline texture are retained. Heated with potass in a tube, it gives off globules of mercury; and the existence of sulphur in the flux may be proved by the escape of sulphuretted-hydrogen on the addition of a mineral acid.

3. *Of Turbith Mineral.*

The Turbith Mineral, or subsulphate of the peroxide of mercury, exists in the form of a bright lemon-yellow, heavy powder. It is soluble in 2000 parts of water, and has an acrid taste.

It may be known by the effects of heat. When heated in a tube, globules of mercury are sublimed, and at the same time sulphurous acid gas is disengaged, as may be ascertained by the smell. But a better method of proving the existence of sulphuric acid in it is to expose it to the action of a solution of caustic potass: The potass separates from it the brownish-yellow peroxide, and appropriates the sulphuric acid, which may be found in the solution by acidulating with nitric acid, and then adding hydrochlorate of baryta, when a heavy, snow-white precipitate will form, namely, the sulphate of baryta. The nitric acid used in this process must be quite pure, and free from sulphuric acid, which the acid of commerce usually contains.

4. *Of Calomel.*

Calomel, (muriate, mild muriate, protochloride of mercury,) is commonly met with in the shops in the form of a heavy powder, having a faint yellowish-white colour, and no taste or smell. In mass it forms compact, fibrous, translucent, shining cakes of great density. It is insoluble in water.

It is distinguished by the effects of heat, and those of the solution of caustic potass. Heated in a tube it sublimes unchanged, and condenses in a crystalline or crumbly mass. The solution of caustic potass, as well as the other caustic alkalis, turns it at once black, disengaging protoxide of mercury and appropriating hydrochloric acid, the presence of which is proved by neutralizing the solution with nitric acid, and then adding nitrate of silver, when a heavy white precipitate is formed, the chloride of silver. In applying this process, care must be taken to employ potass quite free from muriates and nitric acid free from muriatic acid. In this action of the potass some water is decomposed, the oxygen of which unites with the mercury, and the hydrogen with the chlorine to form hydrochloric acid.

5. *Of Corrosive Sublimate.*

Corrosive Sublimate, (oxymuriate, corrosive muriate, b
ride of mercury,) is by far the most important of the mer
poisons, as it is both the most active of them, and that wh
most frequently used for criminal purposes. It is comn
met with in the form of a heavy, snow-white powder, or of
broken crystals, or in white, compact, concave, crystalline c
It is permanent in the air; but in the sunshine is slowly de
posed, a gray insoluble powder being formed. It readily
tallizes, and the common form of the crystals is the quadra
lar prism. Its specific gravity is 5.2. Its taste is strc
styptic, metallic, acrid, and persistent; and its dust power
irritates the nostrils. It is soluble, according to Thenar
20, according to Orfila, in 11 parts of temperate water, ai
thrice its weight of boiling water. Its solution faintly red
litmus. It is more soluble in alcohol than in water, bo
alcohol dissolving its own weight, and retaining, when it c
a fourth part. It is also very soluble in ether, so that ether
remove it from its aqueous solution. Corrosive sublimate
become the subject of a medico-legal analysis in three states
may be in the solid form; it may be dissolved in water a
with other mineral substances; and it may be mixed with v
table and animal fluids or solids.

Of the Tests for Corrosive Sublimate in the solid state.

Corrosive Sublimate in the solid state is distinguished f
other substances by the action of heat, and the effects of the
lution of caustic potass. Subjected to heat alone it sublime
white acrid fumes; and if the experiment is made in a li
tube, it condenses again unaltered in a crystalline cake. Tr
ed with the solution of caustic potass, it becomes yellow,
peroxide being disengaged, and hydrochloric acid uniting w
the potass, as may be proved by nitrate of silver, after filtrat
and neutralization with nitric acid. The fine yellow colou
the peroxide which is separated in this process distinguishes
corrosive sublimate from calomel, which is also decomposed
the potass solution, but yields a black protoxide. In this act
of the potass water is decomposed, as when calomel is acted
by the same agent. Caustic soda has the same effect. Not
caustic ammonia: Ammonia blackens calomel, but does

change the colour of corrosive sublimate, as it forms with it a white triple salt.

The process here described is the best and simplest method of determining chemically the nature of corrosive sublimate in its solid state. But two other tests may also be mentioned, as they have been a good deal used. A very good test is the process of reduction with potass, by which globules of mercury are sublimed, and a chloride of potassium left in the flux, as may be proved by the action of nitrate of silver on the solution of the flux previously neutralized with nitric acid. This test alone will not distinguish corrosive sublimate from calomel: The solubility of the former must be taken into account.—Another very elegant test is the solution of the Protochloride of Tin. Corrosive sublimate, when left for some time in this solution, first becomes grayish-black, and in no long time its place is supplied by globules of mercury,—the chlorine being entirely abstracted by the protochloride of tin, which consequently passes to the state of a bichloride*. Calomel is similarly affected.

Of the Tests for Corrosive Sublimate in a state of Solution.

Two processes, as in the instance of arsenic, may here also be mentioned for the detection of corrosive sublimate in mineral solutions,—a process by reduction, and a process by liquid tests.

Reduction process.—In order to procure mercury in its characteristic metallic state from a solution of corrosive sublimate the following plan of procedure will be found the most delicate and convenient. Add to the solution, previously acidulated with hydrochloric acid if very weak, a little of the protochloride of tin, which will be seen presently to be a liquid reagent of very great delicacy. If the solution is not darkened there is not present an appreciable quantity of mercury. If mercury is present, a bluish-gray or grayish-black precipitate falls down, owing to the chemical action already particularized. After ebullition, this precipitate is to be allowed to subside first in a tall glass vessel suited to the quantity of the solution, and afterwards

* In this view of the chemical changes which take place during the action of the test, both the corrosive sublimate and the salt of tin are supposed to be dissolved in the form of chlorides. The explanation required on the supposition that these salts, when dissolved, become hydrochlorates of the oxides, as many chemists conceive, is obvious.

in the small glass tube, Fig. 7, the superincumbent fluid being previously decanted off as far as possible. After it has subsided in the tube, the remaining fluid is withdrawn with the pipette, Fig. 8, water is poured over it, and withdrawn again after the precipitate has subsided a third time. The bottom of the tube is then cut off with a file, and the moisture which remains is driven off with a gentle heat. When this is accomplished, the powder, which is nothing else than metallic mercury, sometimes runs into globules. If it does not, the bit of tube is to be broken in pieces and heated in the tube, Fig. 1, when a brilliant ring of fine globules will be formed. If the globules are too minute to be visible to the naked eye, the tube is to be cut off with the file close to the ring; and the globules may then be easily made to coalesce into one or more of visible magnitude by scraping the inside of the tube with the point of a pen-knife.

This process is not recommended as preferable to the plan by liquid reagents which is next to be mentioned, and which is both more easily put in practice, and is at the same time quite as satisfactory. It is related chiefly because it forms the groundwork of the process to be afterwards proposed for detecting mercury in mixed animal or vegetable fluids.—It will be remarked that the process does not prove with what acid the mercury was combined in the solution. But this is a defect of very little consequence; for the only other soluble salts of mercury ever met with in the arts, namely, the nitrate, acetate, and cyanide, are too rare to be the source of any material fallacy; and are besides all equally poisonous with the corrosive sublimate.

Process by Liquid Tests.—The process by Liquid Reagents consists in the application of several tests to separate portions of the solution. The tests which appear to me the most satisfactory are the four following,—sulphuretted-hydrogen gas, hydriodate of potass, protochloride of tin, and nitrate of silver.

1. *Sulphuretted-Hydrogen Gas* transmitted in a stream through a solution of corrosive sublimate causes a dark brownish-black precipitate, the bisulphuret of mercury. When the solution is not very diluted, the gas forms a whitish or yellowish precipitate before the blackening commences,—an effect which, according to Pfaff, distinguishes the salts of the peroxide of mercury from all other metals that are thrown down black from their solutions by sulphuretted-hydrogen *. Sulphuretted-hy-

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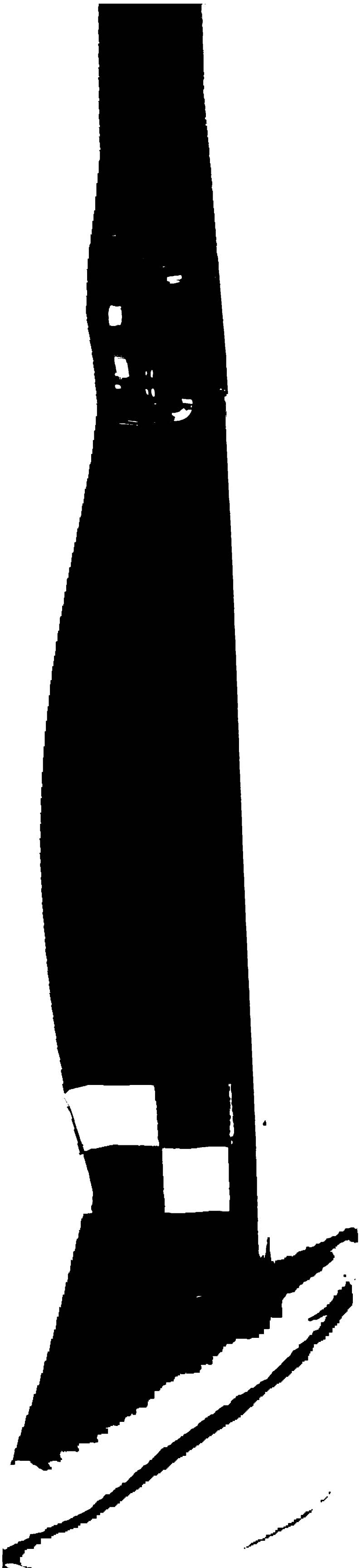
* Kopp's Jahrbuch der Staatsarzneikunde, iv. 354.



ish or grayish-black from the beginning. In such solutions *Devergie* has found it useful to acidulate with hydrochloric acid before adding the test. The chemical action here is peculiar. The white powder thrown down at first is the protochloride of mercury; a part of the chlorine of the bichloride of mercury having been abstracted by the protochloride of tin, which becomes in consequence the bichloride. On more of the test being added these changes are repeated, the chlorine is removed from the protochloride of mercury, and metallic mercury falls down. This test is one of extreme delicacy, acting in solutions which contain only an 80000th of salt. It is prepared by acting on tin powder or tinfoil with strong muriatic acid aided by a gentle heat. The solution must be kept carefully excluded from the air; otherwise the bichloride of tin is formed, which does not act at all on the solution of corrosive sublimate.

The protochloride of tin is not liable to any fallacy. Neither is it liable to be suspended in its action by the co-existence of other saline substances. It causes precipitates with almost all animal and most vegetable fluids. But when corrosive sublimate is present, even in very small proportion, the precipitate is always darker than when no mercurial salt exists in solution, and frequently has its proper grayish-black tint. This property, as will presently be seen, is the foundation of a process for the detection of mercury in all states of admixture with organic matters.

Nitrate of Silver causes a heavy white precipitate, the chloride of silver, which darkens under exposure to light. This is a test for the chlorine of the corrosive sublimate, but not for the mercury, and is a necessary addition to the three former tests in order to determine how the mercury is kept in solution. It acts with very great delicacy.

It is of no use, however, when chlorine or hydrochloric acid is present either free or combined with other bases. It is not of use, therefore, in animal fluids and vegetable infusions, because very many of them, besides organic principles which form white precipitates with this test, contain a sensible proportion of hydrochlorate of soda.

Although the preceding liquid reagents when employed conjunctly are amply sufficient for determining the presence of corrosive sublimate in a fluid, many other tests hardly less characteristic and delicate have been used by medical jurists. These will now be shortly mentioned.

1. *Lime-Water* throws down the peroxide of mercury in the form of a heavy yellow powder. The precipitate first thrown down is lemon-yellow, an additional quantity of the test gives it a reddish-yellow tint, and a still larger quantity restores the lemon yellow. This test is very characteristic, but not so delicate as those already mentioned.—2. *Caustic Potass* has precisely the same effect as lime-water, except that the tint of the precipitate is always yellow. It is not more delicate than lime-water.—3. *Caustic Ammonia* causes a fine, white, flocculent, precipitate, which is a triple compound of ammonia, chlorine, and mercury. It is a very delicate test; but ammonia likewise causes a white precipitate in other metallic solutions.—4. *Carbonate of Potass* causes a brick-red precipitate, by virtue of a double decomposition, the precipitate being carbonate of mercury.—5. The *Ferro-cyanate of Potass* causes at first a white precipitate, the ferro-cyanate of mercury. The precipitate becomes slowly yellowish, and at length pale blue, owing, it is believed, to the admixture of a small quantity of iron with the corrosive sublimate.—6. *A polished plate of Copper* immersed in a solution of corrosive sublimate becomes in a few seconds tarnished and brownish; and in the course of half an hour a grayish-white powder is formed on its surface. This powder, according to *Orfila* [*], is a mixture of calomel, mercury, and a copper amalgam. If it is wiped off, and the plate then rubbed briskly where tarnished, it assumes a white argentine appearance.—7. *A little mercury* put into a solution of corrosive sublimate is instantly tarnished on the surface; the solution in a few seconds becomes turbid, a heavy grayish precipitate is formed, and in no long time with the aid of agitation the whole corrosive sublimate is removed from the solution. The powdery precipitate is a mixture of finely divided mercury and calomel; the former being derived from the surface of the mercury, and the latter produced by the corrosive sublimate uniting with a larger proportion of the metal to form the protochloride.—8. *A solution of Albumen* causes a white precipitate, which is soluble in a considerable excess of the reagent. The precipitate is a compound of calomel and albumen,—a chloride of albumen

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[*] Toxicologie Générale, i. 241.

and mercury. The nature of this compound, and of the chemical action by which it is formed, will be examined presently. —A *slip of Gold*, aided by galvanism, becomes silver-white in the solution, in consequence of the formation of an amalgam. When the solution is concentrated, it may be thus tested by simply putting a few drops on a bit of gold, and touching the gold through the solution with an iron point, as recommended by *Mr Sylvester* and *Dr Paris*[*]. When the solution is very weak, a different method is necessary, and a process for the purpose has been proposed by *M. Devergie*, which appears so delicate, accurate, and at the same time simple a mode of detecting traces of mercury in very weak solutions, as to deserve detailed notice. A thin plate of gold, and another of tin, a few lines broad, and two or three inches long, being closely applied to one another by silk threads at the ends, and then twisted spirally, this galvanic pile is left for twenty-four or thirty-six hours in the solution previously acidulated with muriatic acid; upon which the gold is found whitened, and mercury may be obtained in globules by heating the gold in a tube. Distinct indications may be obtained by this method, where the corrosive sublimate forms but an 80,000th of the water[†]. For facility of application, an important condition is, that the quantity of fluid should not exceed three or four ounces, because in a larger quantity the pile of the size stated above cannot remove the whole mercury. Somewhat similar to this is the galvanic method lately proposed by *Mr Davy* of Dublin. He proposes to place the suspected solution in a platinum crucible with muriatic acid, diluted with its own weight of water, to excite galvanic action by immersing in the fluid a plate of zinc, and to sublime and collect the reduced mercury, by washing the crucible, heating it over a spirit-lamp, and condensing the mercurial vapours on a plate of glass placed over the mouth of the crucible[‡].

Of the Tests for Corrosive Sublimate when mixed with Organic Fluids and Solids.

The process for detecting corrosive sublimate in mixtures of organic fluids and solids, such as the contents of the stomach, is now to be described. But some remarks are previously required on the chemical relations subsisting between this poison and various principles of the vegetable and animal kingdoms.

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[*] Medical Jurisprudence, ii. 208.

[†] Annales d'Hyg. Publ. et de Méd. Lég. xi. 411.

[‡] Philosophical Transactions, 1831, cxxi. 155, 160.

These relations are important in a medico-legal point of view on several grounds. On the one hand, the chemical changes which corrosive sublimate undergoes often alter so much the action of its tests, as to render necessary a process of analysis materially different from any hitherto described. And on the other hand, these chemical changes, of which some take place rapidly, others slowly, will hinder the corrosive sublimate, more or less completely, from exerting its usual operation on the animal system; so that it may thus either accidentally fail to act as intended, or be checked in its operation by antidotes administered for the purpose.

It appears from the researches of *M. Boullay*, confirmed by those of *Professor Orfila*, that various vegetable fluids, extracts, fixed oils, volatile oils and resins, possess the power of decomposing corrosive sublimate. According to *M. Boullay*, a part of the chlorine is gradually disengaged in the form of muriatic acid, and the salt is consequently converted into calomel, which is deposited in a state of mixture with vegetable matter, and may be procured in a state of purity by dissolving the impurities with boiling acetic acid *. It is probable, however, that the vegetable matter is frequently united with the calomel, so as to form a ternary chemical compound. Some vegetable fluids produce this change at once, others not for some hours, others not for days, and only when aided by a temperature approaching that of ebullition. For example, a strong infusion of tea, mixed with a solution of a few grains of corrosive sublimate, becomes immediately muddy, and an insoluble cloud separates in half an hour. But the remaining fluid slowly becomes muddy again, and in eight days a considerable precipitate is formed. Both precipitates contain mercury; the former, I find, contains 31 per cent. On the other hand, an infusion of galls in like circumstances does not become muddy for six or seven hours. A solution of sugar does not undergo any change after being mixed with a solution of corrosive sublimate for months at the ordinary temperature of the atmosphere; but at the temperature of ebullition *Boullay* has found that the usual changes ensue, though to no great extent.

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* Annales de Chimie, xliv. 176, and *Orfila*, Toxicol. Gén. i. 243.

The experiments of *Professor Taddei* of Florence have farther shown, that the property of decomposing corrosive sublimate is possessed in an eminent degree by one of the vegetable solids, gluten. If the salt in solution is properly mixed with a due proportion of gluten of wheat, that is, about four times its weight, the water will be found no longer to contain any mercury, while the gluten becomes whitish, brittle, hard, and not prone to putrefaction. A ternary compound is formed, the protochloride of mercury and gluten [*]. This change is effected with rapidity.

The researches of *Berthollet* [†], lately repeated and extended by *Professor Orfila* [‡], have also shown that the same property is possessed by most animal fluids and solids. Among the soluble animal principles, abumen, casein, osmazome, and gelatin possess it in a high degree, but above all albumen, the action of which has been examined with some care, as it supplies the physician with the most convenient and effectual antidote against the effects of the poison.

If a solution of albumen, for example that procured by beating white of eggs in water, is dropped by degrees into a solution of corrosive sublimate, a white, flaky precipitate is immediately thrown down, which when separated and dried forms horny masses, hard, brittle, and pulverizable. The precipitate is soluble in a considerable excess of albumen; so that wherever albumen abounds in any fluid, to which corrosive sublimate has been added, a portion of the mercury will always be found in solution. The precipitate is also soluble in a considerable excess of corrosive sublimate. The dry precipitate I have found to contain 6 per cent. of metallic mercury.

The action of casein as it exists in milk is precisely the same. If a solution of corrosive sublimate is poured into a large quantity of milk, no change ensues; but if the proportion of salt be considerable, a flaky coagulum is formed, and the milk becomes clear. The principles, osmazôme and gelatin, are similar in their effects, though not quite so powerful. Urea has no chemical action with corrosive sublimate. Of the compound animal fluids, blood and serum have the same effects as albumen.

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[*] *Taddei*, Recherches sur un nouvel Antidote contre le sublimé corrosif.

[†] *Berthollet*, sur la Causticité des sels Metalliques. Mém. de l'Acad. 1780.

[‡] Toxic. Gén. i. 245.

Many insoluble animal principles, as well as all the soft solids of the animal body, act in the same manner with vegetable gluten. Fibrin, for example, coagulated albumen, or coagulated casein, acts precisely in the same manner. Muscular fibre, the mucous and serous membranes, the fibrous textures, and the brain, have all the same effect: They become firmer, brittle, white, and a white powder detaches itself from their surface, which is a compound of chlorine, mercury, and the animal matter with which the corrosive sublimate is in contact. This chemical action, which *Taddei* has proved to take place in the living * as well as in the dead body, is the source of the corrosive property of the poison, as was first pointed out by Berthollet in his essay formerly quoted.

In all of the compounds thus formed by vegetable and animal substances, the presence of mercury is easily proved by boiling the powder in a solution of caustic potass. The organized matter is dissolved; a heavy, grayish-black powder is formed, which is the protoxide of mercury; and if this be collected in the way formerly described, it forms running quicksilver when heated. As the potass thus separates the mercury in the form of protoxide, it follows that it existed in the compound in the form of protochloride. If it existed in the form of bichloride, as some have imagined †, the powder would have been the yellow deutoxide.

With regard to the changes induced by these effects of organized matter on the operation of the liquid tests for corrosive sublimate, it will in the first place be manifest that the poison may thus be wholly removed from their sphere of action: It may be thrown down as an insoluble substance, on which any process by liquid tests hitherto mentioned will of course fail to act. But secondly, even when a moderate quantity does remain in solution, the operation of the liquid tests, as formerly noticed under the head of each, will be materially modified. It is of some moment for the medical jurist to remember, that by reason of the slowness with which the changes in question sometimes take place, the poison may exist abundantly in solution at one time, and yet be present only in small quantity after an interval of some hours or days.

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* Recherches, &c. p. 60.

† *Chantourelle*, Journ. Gén. de Médecine, Octobre 1822.

Process for Organic Mixtures.—It is only within a few years that good methods have been devised for detecting corrosive sublimate, when it exists in mixtures of the kind now described, and in the minute proportion in which the medical jurist will generally have to search for it. In the first edition of this work it was stated that the processes then in common use were insufficient in such circumstances, and a new method was proposed which seemed to me superior. This on careful consideration I am still disposed to retain, with one or two modifications suggested by my own ulterior experience, and by the critiques of others, more especially of *M. Devergie*[†]. Other processes have since come under my notice, which are probably not inferior; and they will therefore be annexed. But for reasons stated in the preface to the present edition, I do not pretend to decide which of them all is the best.

The process I am still inclined to recommend is a double one; of which sometimes the first part, sometimes the second, sometimes both may be required. The first removes the corrosive sublimate undecomposed from the mixture, which may be accomplished when its proportion is not minute; the second, when the proportion of corrosive sublimate is too small to admit of being so removed, separates from the mixture metallic mercury; and the analyst will know which of the two to employ by using the protochloride of tin as a trial-test in the following manner.

A fluid mixture being in the first instance made, if necessary, by dividing and bruising all soft solids into very small fragments, and boiling the mass in distilled water, a small portion is to be filtered for the trial. If the protochloride of tin causes a pretty deep ash-gray or grayish-black colour, the first process will probably be successful; if the shade acquired is not deep, that process may be neglected, and the second put in practice at once.

First branch of the Process.—In order to remove the corrosive sublimate undecomposed, the mixture, without filtration, is to be agitated for a few minutes with about a fourth part of its volume of sulphuric ether; which possesses the property of

[*] Annales d'Hyg. Publique et de Méd. Légale, xi. 426.

abstracting the salt from its aqueous solution. On remaining at rest for half a minute or a little more, the etherial solution rises to the surface, and may then be removed by suction with the pipette, (Fig. 8.) It is next to be filtered if requisite, evaporated to dryness, and the residue treated with boiling water; upon which a solution is procured that will present the properties formerly mentioned as belonging to corrosive sublimate in its dissolved state.

Second branch of the Process.—If the preceding method should fail, or shall have been judged inapplicable, as will very generally be the case, the mixture is to be treated in the following manner. In the first place, all particles of seeds, leaves, and other fibrous matter of a vegetable nature are to be removed as carefully as possible. This being done, the mixture, without undergoing filtration, is to be treated with protochloride of tin as long as any precipitate or coagulum is formed. If there were solid animal matters in the mixture, besides being cut and carefully bruised as directed above, they should also be brought thoroughly in contact with the salt of tin by trituration. The mixture, even if it contains but a very minute proportion of mercury, will acquire a slate-gray tint, and become easily separable into a liquid and coagulum. The coagulum is to be collected, washed and drained on a filter; from which it is then to be removed without being dried; and care should be taken not to tear away with it any fibres of the paper, as these would obstruct the succeeding operations. The mercury exists in it in the metallic state for reasons formerly mentioned.

The precipitate is next to be boiled in a moderately strong solution of caustic potass contained in a glass flask, or still better in a smooth porcelain vessel glazed with porcelain; and the ebullition is to be continued till all the lumps disappear. The animal and vegetable matter, and oxide of tin united with them, will thus be dissolved; and on the solution being allowed to remain at rest, a heavy grayish-black powder will begin to fall down in a few seconds. This is chiefly metallic mercury, of which, indeed, globules may sometimes be discerned with the naked eye or with a small magnifier.

In order to separate it, leave the solution at rest under a temperature a little short of ebullition for fifteen or twenty minutes, or longer if necessary. Fill up the vessel gently with hot water without disturbing the precipitate, so that a fatty matter, which rises to the surface in the case of most animal mixtures, may be skimmed off first with a spoon, and afterwards with filtering paper. Then withdraw the whole supernatant fluid, which is easily done on account of the great density of the black powder. Transfer the powder into a small glass tube, and wash it by the process of affusion and subsidence till the washings do not taste alkaline. Any fibrous matter which may have escaped notice at the commencement of the process, and any lumpy matter which may have escaped solution by the potass should now be picked out. The black powder is the only part which should be preserved. If the quantity of powder is very minute, an interval of twelve hours should be allowed for each subsidence, and the tube represented in Fig. 7 should be used.

Lastly, the powder is to be removed, heated, and sublimed, as in the last stage of the process described in page 343, for detecting corrosive sublimate in a pure solution.

The second branch of this process is very delicate. I have detected by it a quarter of a grain of corrosive sublimate mixed with two ounces of beef, or with five ounces of new milk, or porter, or tea made with a liberal allowance of cream and sugar. I have also detected a tenth part of a grain in four ounces of the last mixture, that is in 19,200 times its weight.

It may be applied successfully and without difficulty to a very large majority of medico-legal cases. The only difficulty in the way of applying it to all organic mixtures whatever arises from the occasional presence of some vegetable matters, such as seeds, leaves, ligneous fibre and the like, which are insoluble in caustic potass, and which may therefore be left behind with the mercurial precipitate and obstruct the subsequent sublimation of the metal. This difficulty may be sometimes got rid of, as recommended above, by picking such matters out of the mixture before the protochloride of tin is added to it. No mercury is lost by so doing, for none of it is united with these vegetable matters: Corrosive sublimate does not form any chemical compound with them as it does with other vegetable matters soluble in caustic potass, and with the soft animal solids. When the particles are too small to admit of being thus removed, or cannot be afterwards removed during the process of washing the black powder, which is left after the action of potass—the analyst must be content with the increased facility of sublimation derived from the abstraction of the other vegetable and animal admixtures, and take care to use a tube of greater length and with a larger ball than usual. If the sublimate is too much obscured by empyreumatized matter to exhibit distinctly its metallic, globular appearance, the portion of the tube is to be broken off, and scraped, washed, and boiled with a little distilled water in a tube. If the globules do not then become visible, a second sublimation will render them distinct. This supplemental operation, however, will be very seldom required; and the process given above will be found to apply to a great majority of instances.

Various objections brought against this process by reviewers and others were noticed in the last Edition, their force discussed, and some improvements proposed. These objections it is scarcely necessary to reproduce here. A new objection has been since stated by *M. Devergie*,—that where corrosive sublimate has acted on the animal tissues and united with them, the mercurial compound so formed is decomposed by the salt of tin on the surface only of the texture, and not in its deeper portion; and that in consequence but a small part of the mercury is ultimately obtained. This difficulty is met, I conceive, by the simple and obvious precaution of dividing the soft solid matters in the mixture very finely, and subjecting the whole to trituration after adding the salt of tin.

A reviewer of the first Edition correctly reminded me of having omitted an important fallacy to which every process for the detection of mercury in compound mixtures is exposed. In the case of the contents of the stomach, if the mercury is not detected in the filtered fluid, it is impossible to know whether the mercury detected in the solid matter only may not have proceeded from calomel given medicinally. This objection can be obviated solely by sufficient evidence that calomel was not administered; at least the different criterions laid down by *Professor Orfila* for distinguishing calomel in the alimentary canal from the insoluble chloride of mercury and albumen do not appear sufficiently precise, or generally applicable *.

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* Toxicologie Générale, i. 301.

It will now be requisite to mention some other important processes, which have been proposed by different toxicologists and chemists for detecting mercury in compound organic mixtures,—more especially as some of them are perhaps not inferior in delicacy or facility to that preferred above, while others are more general in their application.

1. and 2. In the earlier editions of this work two methods are criticized, which for brevity's sake may be here omitted, since they are now commonly abandoned as inferior to the others. It is necessary, however, to repeat that the *First Branch* of my own process is borrowed from one of them, the original process of *Orfila*.

3. The next is a valuable process proposed by *M. Devergie* in 1828 *, and lately improved by him since some strictures made on it by Orfila as well as myself. Filter the mixture. Test the fluid part by galvanism, as described in page 347. If mercury be not there discovered, heat the solid matter gently in a glass or porcelain vessel, add successive small portions of concentrated muriatic acid, maintaining the heat a little below ebullition and stirring and bruising the solid parts diligently. A uniform soft pulp will at length be obtained, from which most of the acid is to be expelled by evaporating gently, yet not to dryness. The residuum is then to be acted on by water added in small successive quantities till the pulp is thin enough to allow a stream of gas to pass readily through it. Through this pulp chlorine is to be transmitted till the precipitation it causes acquires a white or grayish tint; the effect of which is to bring the whole mercury into the state of bichloride in solution. Finally filter, heat the fluid nearly to ebullition and introduce a small plate of burnished pure tin for five minutes, and then one or more fresh plates in succession so long as their surface acquires a dull white tarnish. The tarnish is owing to deposited mercury, which may be obtained pure by drying the plates, scraping off the tarnish, and heating the scrapings in a proper glass tube. A ring of metallic globules will be sublimed †.—I have no doubt that this is an extremely delicate method of analysis.

4. *Professor Orfila* considers that the preliminary action of

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* Revue Médicale, 1828, ii. 471.

† Annales d'Hyg. Publ. et de Méd. Lég. xi. 432.

muriatic acid in Devergie's process is not necessary for the full effect of the chlorine gas in decomposing the mercurial compounds formed with organic matter, and bringing the mercury into solution in the state of bichloride. He therefore proposes to transmit chlorine at once through the suspected mixture, properly diluted if necessary, and to proceed afterwards nearly as Devergie directs [*]. To this method Devergie has made some objections, the force of which Orfila does not admit [†].

5. A modification of the galvanic method was proposed in the Second Edition of this work, p. 346. As Devergie's process, however, is in its various particulars nearly the same and probably in most respects preferable, it may be sufficient to mention here that it was proposed to excite galvanic action by an apparatus like that of *Fischer* and *Torosiewitz* described in page 256, a plate of zinc being placed in an exterior exciting fluid and a small slip of platinum-foil in the suspected liquid properly prepared. This method of collecting the mercury is probably preferable to Devergie's method by plates of tin.

6. Another modification of the galvanic method has been proposed by *Mr Edmund Davy*, which so much resembles his method for extracting arsenic by galvanism that it is not necessary for me to notice it particularly [‡].

7. Another apparently very simple process was proposed by *Professor Buchner* in 1827: He proposes to evaporate the suspected mixture nearly to dryness, and boil the residue in nitromuriatic acid till the decomposition of the organic matter is at an end, which is indicated by the cessation of the discharge of orange fumes. The solution is then treated with sulphuretted-hydrogen gas, which occasions first a white and then a black precipitate. This precipitate is next collected and heated in a tube with a little carbonate of soda deprived by incandescence of its water of crystallization; upon which globules of metallic mercury are sublimed. This process has the advantage of being applicable to mercury in all its states of combination, since nitromuriatic acid dissolves them all. But doubts may be entertained whether it is in every case convenient and delicate. There are some organic substances which boiling nitric acid

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[*] Cours de Méd. Légale, iii. 115.

[†] Annales d'Hyg. Publ. et de Méd. Lég. xi. 429, 438, and xiii. 493.

[‡] Philosophical Transactions, 1831. cxxi.

does not destroy, but merely modifies or alters, and consequently a mixed solution is procured, to which the subsequent steps of the process cannot always be effectually applied. Either on this account or from ignorance of the proper manipulations, I have been unable to detect by Buchner's process a quarter of a grain of corrosive sublimate in four ounces of milk.

8. Two other processes may next be mentioned, both of them modifications of that of Buchner, but probably conceived and published by their authors without being aware of his researches. The first has been suggested by *Dr O'Shaughnessey.* He proposes to try a small portion of the suspected mixture, first by ether, and then by protochloride of tin in the manner I have recommended. If no indication of mercury is procured, mercury may still be present in the form of one of its compounds, on which the protochloride of tin, as formerly noticed, has but little action. These are to be sought for in the following manner. Filter, acidulate the fluid part with nitric acid, and concentrate by evaporation. Boil the solid part in solution of caustic potass, add a large excess of nitric acid, digest with a gentle heat in a Florence flask for at least six hours. Filter, unite with the fluid part of the mixture, and concentrate the whole by evaporation as much as possible. Filter again after cooling. Introduce into this fluid a thin slip of gold bound with a coil of iron wire, when amalgamation of the gold will ensue; and the mercury may be procured by scraping off the gold amalgam and heating it in a tube *.—The general applicability of this process must be determined by experience. The author found it to answer when a thirtieth of a grain of calomel was mixed with ten ounces of tea and two ounces of human blood.

9. The following analogous process intermediate between that of Devergie and my own has been suggested by *Dr Venables* of Chelmsford. Nitric acid in excess is agitated on the solid matter of the mixture. Chlorine gas is then transmitted through the fluid to convert the mercury into the chloride. The mixture is next boiled to destroy organic matter as much as possible, then filtered and evaporated; and as it becomes dark or thick under evaporation, solution of chlorine is added from time to time. When this alternate concentration and addition of chlorine has been continued to a sufficient de-

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* Lancet, 1830-31, i. 420.

gree, the fluid retains only a feeble action on litmus. It is then neutralized with potass, filtered and treated with protochloride of tin. The precipitate is lastly to be collected in the manner described above, (p. 342,) and the mercury sublimed in a tube *. The object of the first steps in this process is on the one hand to remove organic matter, before proceeding to the more essential operation of separating the mercury in the metallic state, —and on the other hand to comprehend every possible condition in which the poison may exist. For the latter purpose it may be required; but I am not prepared to allow that it is necessary for the former object; at least I have never found the presence of organic matter an obstacle to the discovery of the mercury by the direct use of protochloride of tin, followed by the action of potass on the precipitate,—even where the proportion and quantity of the mercury were very inconsiderable. Dr Venables applied his process to the tissues of the stomach and duodenum in a case of poisoning with corrosive sublimate, and was successful, although the patient lived eight days and had vomited much at first.

The reader will conclude from what has now been said, that the toxicologist is at length in possession of a great variety of good processes for detecting mercury. A long experimental inquiry would be requisite for deciding which is the most delicate.

6. *Of Cyanide of Mercury.*

The Cyanide of Mercury is a compound of mercury and cyanogen. It is usually sold in the form of white opaque, heavy, crystals, which are rhomboidal prisms. It has a disagreeable metallic taste. It is easily known from every other substance by the effects of heat. If a small quantity of it, previously well dried, be introduced into a glass phial to which a small tube is fitted by means of a cork, on the application of heat the salt chars, mercury is sublimed, and condenses in globules on the upper part of the phial, and a gas escapes from the tube, which has the odour of prussic acid, and burns with a beautiful rose-red flame.

7. *Of the Nitrates of Mercury.*

The Nitrates of Mercury are used in some of the arts, but have so very rarely been the cause of injury to man that they are of little medico-legal importance. I am acquainted with only one case of poisoning with them *.

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* London Medical Gazette, 1831, viii. 620.

There are two nitrates, the protonitrate and pernitrate. 1. The protonitrate is in transparent colourless crystals, entirely soluble in water with the aid of a very slight excess of nitric acid; and the solution is precipitated black by the alkalis, black by sulphuretted-hydrogen, white by muriatic acid, and yellow by hydriodate of potass. The crystals when heated discharge fumes of nitrous acid, and when the whole acid is driven off the red oxide is left, which by farther heat is converted into metallic mercury. 2. The pernitrate is similarly affected by heat. Its crystals form white or yellowish needles. Water decomposes them, separating an insoluble yellowish subnitrate, and dissolving a supernitrate, which is precipitated yellow by the alkalis, black by sulphuretted-hydrogen, carmine-red by the hydriodate of potass.—Copper separates the mercury from both nitrates; and so does gold or platinum when aided by a galvanic current.

SECTION II.—*Of the mode of Action of Mercury and the Symptoms it excites in Man.*

The effects of mercury on the animal body are more diversified than those of any other poison. It acts on a great number of important organs, and in consequence the phenomena of its action are proportionately various. It is not surprising, therefore, that some ambiguity still prevails as to its mode of action and the circumstances by which it is regulated.

The attention of toxicologists in their physiological researches has been chiefly turned to the more active preparations of mercury, and especially to corrosive sublimate, when given in such quantity as to prove fatal in a few days at farthest. The more immediate and prominent properties of corrosive sublimate have consequently received some elucidation. But its qualities as a slow poison, as well as the analogous operation of the less active compounds of mercury, have not been experimentally examined with the same care: Indeed it is questionable whether the phenomena of the latter description as they occur in man can be studied with much advantage by means of experiments on animals.—In treating of the mode in which the compounds of mercury act, the most convenient method will be to consider at present its action in the form of corrosive sublimate in large doses as ascertained by late experiments, and to reserve the consideration of the action of the mercurial poisons generally till their effects on man have been fully described.

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* *Dr Bigsby* in London Medical Gazette, vii. 329.

The mode of action of corrosive sublimate has been examined particularly by *Mr Brodie* in 1812 *; by *Dr Campbell* in 1813 †, by *M. Smith* in 1815 ‡, *M. Gaspard* in 1821 §, and more lately by *Professor Orfila* ||. The following is a short analysis of their experiments and results.

The leading phenomena remarked by Mr Brodie, on large doses being introduced into the stomach were very rapid death, corrosion of the stomach, and paralysis of the heart. In rabbits and cats, from six to twenty grains, injected in a state of solution into the stomach, produced in a few minutes insensibility and laborious breathing, then convulsions, and death immediately afterwards,—the whole duration of the poisoning varying from five to twenty-five minutes. After death the inner membrane of the stomach was found gray, brittle, and here and there pulpy,—changes precisely the same with those produced by corrosive sublimate on the dead stomach. When the chest was opened immediately after death, the heart was found either motionless or contracting feebly; and in both circumstances the blood in its left cavities was arterial.

It is evident that in these experiments the brain was acted on as well as the heart, and that the immediate cause of death was stoppage of the heart's action. Mr Brodie thinks that these organs could not have been affected through the medium of the blood, because he considers the chemical alteration produced on the villous coat of the stomach to be incompatible with the exercise of the function of absorption there. But the accuracy of this opinion may be doubted. For on the one hand, the chemical action of corrosive sublimate on the external surface of the human body, in other words, its operation as

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* Philosophical Transactions, cii. 222.

† Tentamen Inaugurale de Venenis Mineralibus, Edinb. 1813, p. 36.

‡ Orfila, Toxicologie Générale, i. 257.

§ Journal de Physiologie, i. 165 and 242.

|| Toxicologie, i. 261.

an escharotic, is not incompatible with its being also absorbed; and on the other hand, Mr Brodie found, that its effects when introduced into the stomach are not altered by the previous division of the eighth pair of nerves, as we should expect, did the poison act through sympathy without entering the blood-vessels.

I am not acquainted with any other experiments of consequence on the operation of corrosive sublimate when introduced into the alimentary canal. But some very interesting observations have been made by Campbell, Smith, Gaspard, and Orfila severally as to its effects when applied to the cellular tissue or injected at once into the blood of a vein. It follows from their researches, taken along with those of Mr Brodie, that, like arsenic, corrosive sublimate is an active poison, to whatever part or tissue in the body it is applied.

Campbell, Smith, and Orfila all agree in assigning to it dangerous properties, when it is applied to a wound or the cellular tissue of animals. Even in the solid state, and in the dose of three, four, or five grains only, it causes death in the course of the second, third, fourth, or fifth day. The symptoms antecedent to death were generally those of dysentery; and corresponding appearances were found after death, namely redness, blackness, or even ulceration of the villous coat of the stomach and rectum, the intermediate part of the alimentary canal being sound. This poison, therefore, has, like arsenic, the singular power of inflaming the stomach and intestines, even when it is introduced into the system through a wound.

But this is not its only property in such circumstances. According to Smith and Orfila, it also possesses the power of inflaming both the lungs and the heart. Orfila found the lungs unusually compact and œdematous in some parts; and Smith observed on their anterior surface black spots, elevated in the centre, evidently the consequence of effusion of blood. As to the heart, in one of Smith's experiments black spots were found in its substance, immediately beneath the lining membrane of the ventricles; and Orfila invariably found in one part or another of the lining membrane, most commonly on the valves, little spots of a cherry-red or almost black colour; nay on one occasion he observed these spots so soft that slight friction made little cavities. The production of peripneumony by corrosive sublimate when applied to a wound appears well established; but the appearances assumed as indications of carditis are equivocal, as they may have arisen simply from dyeing of the membrane of the heart in the fluid part of the blood after death.

The researches of Gaspard were confined to the effects of the poison when injected at once into the blood. They show still more clearly its tendency to cause inflammation of the lungs; and they prove that through the channel of the blood, as through the cellular tissue, it is apt to cause inflammation of the stomach and rectum. The symptoms during life were vomiting, bloody diarrhœa, difficult breathing, apparent pain of chest, bloody sputa; and death took place in a few seconds or in three or four days, according to the dose, which varied from one to five grains. The appearances in the dead body were principally redness in the mucous membrane of the intestines: and in the lungs, according to the length of time the animal survived, either black ecchymosed spots, or black tubercular masses, some inflamed, others gangrenous, others suppurated, or finally, regular abscesses separated from one another by healthy pulmonary tissue [*].

Besides the effects mentioned in the preceding abstract, two of the experimentalists referred to have likewise observed in animals the same remarkable operation on the salivary organs which forms so conspicuous a feature in the action of the compounds of mercury on man. Dr Campbell observed mercurial fœtor, and M. Gaspard mercurial salivation. Another writer, *Zeller*, found that dogs might be made to salivate, but not graminivorous animals [†]. *Schubarth*, however, remarked profuse salivation in a horse, to which twenty-four ounces of strong mercurial ointment were administered in the way of friction in sixteen days [‡]; and I observed the same symptoms in a rabbit on the sixth day after the commencement of daily mercurial inunction.

The result of the preceding inquiry is, that corrosive sublimate causes when swallowed, corrosion of the stomach, and in whatever way it obtains entrance into the body, irritation of that organ and of the rectum, inflammation of the lungs, depressed action and perhaps also inflammation of the heart, oppression of the functions of the brain, inflammation of the salivary glands. These phenomena are diversified enough. But it will presently be found that other organs still are implicated in its effects on man.

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[*] Journal de Physiologie, i. 165.

[†] *Autenrieth* und *Zeller*, über das Daseyn von Quecksilber in der Blutmasse der Thiere. *Reil's* Archiv für die Physiologie, viii. 216.

[‡] *Horn's* Archiv für Medizinische Erfahrung, 1823, ii. 417.

Before proceeding, however, to its effects on man, some notice may be taken of a question, connected with its mode of action, which has long been and still is the subject of controversy. The experiments already quoted, although certainly not decisive of the point, nevertheless render it probable that corrosive sublimate, before it can exert its remote action, must enter the blood; and the facts to be enumerated under the next head of the present section will render it probable that the milder compounds of mercury used in medicine also act in a similar manner. Physicians and chemists have therefore endeavoured to discover this metal in the solids and fluids of the body while under its influence; and the failure of some attempts to detect it has naturally led to its presence throughout the system being called in question by many. This inquiry, besides its interest in a physiological point of view, is highly important in respect to medico-legal practice, since it forms a material branch of the general questions which at present occupy the attention of medical jurists,—whether poisons that act through the blood should be sought for by chemical analysis in other parts of the body besides the stomach, intestines, or other organ to which they have been directly applied,—and in what particular quarters the search should be principally made. As no poison seems better fitted for throwing light on these questions than mercury, and as the proofs of its presence in the bodies of men and animals under its influence do not appear to have been fairly stated by some modern authors, the chief facts which have been published on the subject may be here shortly enumerated.

They are derived from observations and experiments made on man and animals after the long-continued use of the milder preparations of mercury; it being imagined that if the poison enters the blood at all, the greatest quantity will be found under these circumstances. The facts thus procured may be arranged under three heads. Some relate to the discharge of metallic mercury from the living body during a mercurial course for medicinal purposes; others to the discovery of metallic mercury in the dead body after a mercurial course; and others to the detection of mercury by a careful chemical analysis in the fluids and solids during life or after death.

Many stories are related by the older authors of the discharge of running quicksilver from the living body during a mercurial course. Some of the most authentic of them have been collected by *Zeller*. In his list of cases it is stated that *Schenkius* met with an instance of the discharge of a spoonful of quicksilver by vomiting; that *Rhodius* twice remarked quicksilver pass with the urine; and that *Hochstetter* once saw it exhaled with the sweat*. *Fallopius* likewise states, that in people who had used mercurial inunction for three years, and who had the bones of the leg laid bare by suppurating nodes, he had seen quicksilver collected in globules on the tibia; and he speaks of its being the practice in his day to draw the mercury from the body, when overloaded with it, by successively amalgamating a bit of gold in the mouth and heating the amalgam to expel the mercury†. With regard to these statements of the older authors it may be observed that, although their singularity renders them questionable, they ought not to be rejected at once, as some have done, merely because corresponding facts have not been witnessed in modern times; for no one can now-a-days have such opportunities for observation as were enjoyed by Fallopius and his contemporaries. It is true that the experiment of amalgamating gold in the mouth of a person under a course of mercury has always failed in modern times. But who can now have an opportunity of making the experiment during a mercurial course of three years? Besides, the statements quoted above are not all destitute of modern confirmation. Thus *Fourcroy* has noticed the case of a gilder attacked with an eruption of little boils, in each of which was contained a globule of quicksilver. *Bruckmann* mentions the case of a lady who subsequently to a course of mercury remarked after a dance many small black stains on her breast, and minute globules of quicksilver in the folds of her shift‡. And *Dr Jourda* has described in a late French periodical a case where fluid mercury was passed by the urine. The last fact appears to me satisfactory in all its circumstances. A patient had been taking corrosive sublimate for a month in the dose of a grain, besides using for the first sixteen days a gargle containing metallic mercury finely divided. Towards the close of the month he observed on the sill of the window, on which he used to turn up his chamber-pot after using it, many little globules of mercury, amounting in all to four grains. Dr Jourda on learning this observation of his patient collected some of his urine with care, and after it had stood some time found in it a black, powdery sediment, which, when separated and dried, formed little globules of mercury *.

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* Diss. Inaug. Tubingæ, 1808, sistens experimenta quædam circa effectus hydrargyri in animalia viva, pp. 25, 31, also Reil's Archiv, *ut supra*.

† Tract. de Morb. Gall. in Opera Omnia, p. 728, 729.

‡ Archiv für Medizinische Erfahrung, 1810, ii. 252.

The next class of facts in favour of the entrance of mercury into the blood are derived from the discovery of metallic mercury in the bodies of persons who have undergone a long mercurial course recently before death. In the German Ephemerides it is said that no less than a pound of it was found in the brain and two ounces in the skull-cap of one who had been long salivated †. This is certainly too marvellous a story to obtain much credit. Nevertheless analogous observations have been made very lately. In *Hufeland's* Journal it is mentioned that a skull found in a churchyard contained running quicksilver in the texture of its bones, and that there is preserved in the Lubben cabinet of midwifery a pelvis infiltered with mercury, and taken from a young woman who died of syphilis ‡. An unequivocal fact of the same nature has been related by *Mr Rigby Brodbelt.* In a body of which he could not learn the history he found mercurial globules as big as a pin-head lying on the os hyoides, laryngeal cartilages, frontal bone, sternum, and tibia §. Another equally unquestionable fact of the kind has been supplied by *Dr Otto.* On scraping the periosteum of several of the bones of a man who had laboured under syphilis, he remarked minute globules issuing from the osseous substance: In some places globules were deposited between the bone and periosteum, where the latter had been detached in the progress of putrefaction; and in other places, when the bones were struck, a shower of fine globules fell from them[*]. *Wibmer* observes that *Fricke*, surgeon to the Hamburg Infirmary, has obtained mercury by boiling the bones of persons who had been long under a course of mercurial inunction[†].

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* Corvisart's Journ. de Méd. xxvii. 244.

† Dec. I. Ann. i. Obs. 8.

‡ Journ. der Prakt. Heilkunde, li. 5, p. 117.

§ Mem. of Lond. Med. Soc. v. 112.

The third and most satisfactory class of facts are the results of actual chemical analysis. These results, however, have unfortunately been variable. On the one hand, *Mayer* not long ago lately subjected to a careful examination the chief solids and fluids of a person who died while taking mercury, but without finding any mercury in them; *Marabelli*, an Italian physiologist, was not more fortunate in some experiments performed with the fluids of living persons[‡]; more lately *M. Devergie* by means of the process described above, (p. 355,) which he considers delicate enough to detect a 122,680th part of corrosive sublimate in blood, endeavoured in vain to discover mercury in the blood, saliva and urine of persons under a mercurial course[§]; and I have likewise tried the process described in page 352 on the solids and blood of two rabbits killed by inunction, but with no better success. On the other hand, *Zeller* has detected it after death in the blood and bile, *Cantu* has likewise procured it from the urine, *Buchner* has found it in the blood, saliva, and urine, and *Schubarth* has likewise extracted it from the blood. The first experimentalist, in the course of his researches, which were carried on under the guidance of Professor Autenrieth of Tubingen, found that in the blood and bile of animals killed by mercurial inunction, mercury could be detected by destructive distillation, but not by any fluid tests[||]. *Cantu*, by operating on sixty pounds of urine, taken from persons under the action of mercury, procured no less than twenty grains of the metal; and he remarks that it was all contained in the sediment, and that the residuum procured when the liquid part was evaporated to dryness, yielded none[¶]. While these apparently pointed facts are quoted, it is right to mention at the same time, that the researches of Cantu are open to fallacy, on account of the obvious difficulty of collecting so large a quantity of urine, from persons who are taking mercury, without the risk of mercury having been accidentally mixed with it; and that since Zeller published his thesis, he repeated his experiments, and sent the blood to Klaproth, and the bile to Bergemann for analysis, neither of whom could detect any mercury; and that his whole train of researches has been more lately repeated by *Rhades*, with the aid both of Meissner and of Schweigger, but with no better success *. The experiments of Buchner are the most satisfactory I have yet seen. By destructive distillation of seven ounces of blood taken from a patient who was salivated by mercury, he could procure no indication of the metal in the serum, but separated rather more than a quarter of a grain of globules from the crassamentum; two pounds of saliva yielded in the same way a 200th of a grain; and the urine contained so much that it became brownish-black with sulphuretted-hydrogen †. Buchner likewise adds, that *Professor Pickel* of Würzburg procured mercury by destructive distillation from the brain of a venereal patient who had long taken corrosive sublimate ‡. Not less satisfactory perhaps are the experiments of *Dr Schubarth*. A horse after being rubbed for twenty-nine days with mercurial ointment to the total amount of eighty ounces, died of fever, emaciation, diarrhœa, and ptyalism. On the sixteenth day, when ptyalism had set in, a quart of blood was drawn from the jugular vein, and after death another quart was collected from the heart, great vessels and lungs,—extreme care being taken to collect it perfectly pure. In each specimen there was procured by destructive distillation a liquor, in which minute metallic globules were visible. A copper coin agitated in the liquor was whitened; and when the oily matter was separated by filtration and boiling in alcohol, the residue gave with nitric acid a solution, which produced an orange precipitate with hydriodate of potass. The quantity of globules, however, was extremely small; and to this extreme minuteness the author ascribes the failure of Klaproth, Bergemann, Rhades, and other experimentalists, who operated on inconsiderable quantities of blood [*].

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[*] Seltene Beobachtungen zur Anat. Physiol. und Pathol. Berlin, 1824, ii. 36. Quoted by *Marx*, die Lehre von den Giften, I. ii. 163.

[†] Die Wirkung der Arzneimittel und Gifte, iii. 86.

[‡] *Zeller*, in Reil's Archiv. viii. 233.

[§] Nouvelle Bibliothèque Médicale, 1828, iv. 17 and 18.

[||] Reil's Archiv, viii. 228.

[¶] Journal der Praktischen Heilkunde, lx. 115.

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* *Rhades*, über den Uebergang von Quecksilber in das Blut. *Meckel's* Archiv. für Anat. und Physiol. vi. 128,—also—Journal Complémentaire, xi. 87.

† Toxikologie 3te Auflage, 539.

‡ *Ibidem*, 433.

Such are the arguments which chemistry has supplied in favour of the absorption of mercury into the circulating system. On the whole, notwithstanding the contradictory facts which have been noticed, they furnish the strongest presumption that it is present in some circumstances in the animal fluids. It remains for the chemical physiologist to determine what are the circumstances in which it may be expected to be present.

In reference, however, to the questions in medico-legal analysis mentioned above, it will be evident, on a moment's consideration, that, even if mercury is always present in the fluids of those poisoned with it, the chemist may not be always able to detect it. The experiments of Gaspard, Orfila, and other physiologists, have proved, that a grain of corrosive sublimate, injected into the blood, or thrust into a wound, in a middle-sized dog, will cause death in two or three days; and consequently, if it acts through absorption, it is quite possible, nay probable, that although a larger quantity is applied to an absorbing surface, a larger proportion may not exist in the blood after death. Now, the whole blood which can be collected from a middle-sized dog will hardly exceed twenty-four ounces, being about a third of the whole blood in its body. Hence, supposing the whole mercury which originally entered the blood to remain in it at the time of death, (a supposition favourable to the analyst, but which, we may be pretty sure, does not hold true), he would have to search for a third of a grain of corrosive sublimate, or, more properly speaking, a quarter of a grain of mercury, mixed with about 50,000 times its weight of blood, —an analysis which could not be brought to a successful issue without very great care and dexterity, and certainly not by any process known prior to the publication of Devergie's method in 1828. If, notwithstanding the difficulty and uncertainty of the analysis, any one should feel disposed to pursue the subject practically, the most likely quarter for finding the mercury in persons poisoned with it appears to be the blood, or the urine, more especially the latter.

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[*] Beiträge zur näheren Kentniss der Arzneimittel und Gifte. *Horn's* Archiv, 1823, ii. 419.

The cases of poisoning with mercury which have been observed in the human subject may be conveniently arranged under three varieties. In one variety the sole or leading symptoms are those of violent irritation of the alimentary canal. In another variety the symptoms are at first the same as in the former, but subsequently become conjoined with salivation and inflammation of the mouth, or some of the other disorders incident to mercurial erethysm, as it is called. In a third variety the preliminary stage of irritation in the alimentary canal is wanting, and the symptoms are from beginning to end those of mercurial erethysm in one or other of its multifarious forms.

The first variety of poisoning with mercury is remarked only in those who have taken considerable doses of its soluble salts, particularly corrosive sublimate. The second is caused by the same preparations. The third may be caused by any of the compounds of mercury.

1. The symptoms in the first variety are very like those already described as occurring in the ordinary cases of poisoning with arsenic,—namely vomiting, especially when any thing is swallowed, violent pain in the pit of the stomach, as well as over the whole belly, and profuse diarrhœa. But there exist between the effects of the two poisons some shades of difference which it is necessary to attend to.

In the first place,—taking corrosive sublimate as the best example of the preparations which cause this variety of poisoning with mercury,—the symptoms begin much sooner than those caused by arsenic. The symptoms of irritation in the throat may begin immediately, nay even during the very act of swallowing [*]; and those in the stomach may appear either immediately [†], or within five minutes [‡].

Secondly, the taste is much more unequivocal and strong. Even a small quantity of corrosive sublimate, either in the solid or fluid state, and considerably diluted, has so strong and so horrible a taste, that I should think no one could swallow it in a form capable of causing much irritation in the stomach without being at once made sensible by the taste that he had taken something unusual and injurious. People have in fact been occasionally thus warned of their danger while in the act of swallowing the poison, and have consequently stopped in time to prevent fatal consequences [*].

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[*] Hodgson's Trial, Edin. Med. and Surg. Journal, xxii. 439, also case by *Mr Blacklock, Ibid.* xxxvi. 92.

[†] Case by Ollivier in Archives Gén. de Méd. ix. 100; also one by Mr Valentine, Edin. Med. and Surg. Journal, xiv. 471.

[‡] Case by *Fontenelle*, Arch. Gén. de Méd. v. 345; also Hodgson's Trial.

Thirdly, the sense of acridity which it excites in the gullet during the act of deglutition, and throughout the whole course of the subsequent inflammation of the alimentary canal, is usually much stronger. If the dose is not inconsiderable, or very largely diluted, or in the solid form, the sense of tightness, acridity, or burning in the throat and gullet during deglutition is often far greater than ever occurs in the instance of arsenic; and sometimes it is very severe even when corrosive sublimate is taken in the solid form [†]. The tightness and burning in the throat often continue throughout the whole duration of the poisoning; and may be so excessive as to cause complete inability to swallow [‡], or even to speak [§]. Occasionally the affection of the throat is the only material injury inflicted by the poison, as in a case related by *Dr J. Johnstone* of a young woman, who tried to swallow two drachms of corrosive sublimate in the solid state, but was unable to force it down on account of the constriction it caused in the gullet. She died in six days of mortification of the throat [||]. The greater violence of the action of corrosive sublimate on the throat, compared with that of arsenic, is evidently owing to its greater solubility and powerful chemical operation on the animal textures.

Fourthly, instead of the contracted ghastly countenance observed in cases of poisoning with arsenic, (but which it will be remembered is not invariable in that kind of poisoning), those who are suffering under the primary effects of corrosive sublimate have frequently the countenance much flushed, and even swelled [¶].

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[*] Hogdson's Trial; also Orfila, Tox. Gén. i. 263; and Mr Valentine's 5th case, the only survivor.

[†] Hogdson's Trial; also Mr Buchanan's case in Lond. Med. Repos. xix. 374.

[‡] Mr Valentine's Cases, Edin. Med. and Surg. Journal, xiv. 470.

[§] Mr Anderson's case in Edin. Med. and Surg. Journal, xiv. 474.

[||] Essay on Mineral Poisons, p. 52.

[¶] Dumonceau in Journ. de Méd. lxix. 36; Orfila, Tox. Gén. i. 264; and Blacklock's case.

Corrosive sublimate seems also to occasion n than arsenic the discharge of blood by vomitin —obviously because it is a more powerful irrit

It likewise gives rise perhaps more frequent of the urinary passages. This irritation gener frequent and painful micturition; but the secret often suppressed altogether. Instances of this related by *Mr Valentine* [*], by my colleague, *Pr* by an anonymous writer in the Medical and nal [‡], by *Dr Venables* [§], by *Mr Blacklock* [‖], an *vier*, in whose case, however, the poison was mercury [¶]. In the three last cases the suppres and continued till death, which did not ensue, in in the next till five, and in the last till nine days son was taken. Sometimes, as in Ollivier's case irritation is attended with symptoms of excitemen nal parts, such as swelling and blackness of the erection of the penis.

Another distinction seems to be that corrosiv more apt than arsenic to cause nervous affectio first inflammatory stage. The tendency to doze times interrupts the inflammatory symptoms caus has been more frequently observed in cases of p corrosive sublimate [**]. The same may be said o and twitches of the extremities. Sometimes th proaches even to absolute coma [††]; and the twit ally amount to distinct, nay violent convulsions [‡‡] instances paraplegia has been witnessed [§§].

Another difference is, that the effects of the m tants are fully more curable than those of arsenic has taken place even after half an ounce was swa the effect of inducing both bloody vomiting and purging*. This may depend in part on the greater solubility of the mercurial preparations, so that they are more easily discharged than arsenic, which often remains in the stomach after days of continued vomiting, and in part on corrosive sublimate and the other soluble salts of mercury being in no long time and much more easily converted into comparatively innocuous compounds, either by antidotes intentionally given for that purpose, or by animal principles in the secretions and accidental contents of the alimentary canal.

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[*] See his five cases in Edin. Med. and Surg. Journal, xiv. 46

[†] Ibid. xliv. 26.

[‡] xli. 204.

[§] London Medical Gazette, viii. 616.

[‖] Edin. Med. and Surg. Journal. xxxvi. 92.

[¶] Archives Gén. de Méd. ix. 99.

[**] Orfila, Tox. Gén. i. 265.

[††] Mr Valentine's cases.

[‡‡] Ollivier's case, and Fontenelle's.

[§§] Case by Devergie in Arch. Gén. de Méd. ix. 463.

Lastly, deviations from the ordinary course and combination of the symptoms appear to be more rare in the instance of corrosive sublimate than in that of arsenic.

To these general statements, it may be right to add the heads of one or two actual cases, lest an exaggerated idea be conveyed of the combination of the symptoms as they usually occur. For this purpose it will be sufficient to refer to a fatal case related by *M. Devergie*, and to an instance of recovery, without salivation having supervened, which is contained in *Orfila's* Toxicology.—In Devergie's case, the patient, a female, swallowed three drachms of corrosive sublimate in solution, and was soon after seized with vomiting, purging, and pain in the belly. In five hours, when she was first seen by Devergie, the skin was cold and damp, the limbs relaxed, the face pale, the eyes dull, and expressive of horror and anxiety. The lips and tongue were white and shrivelled, and she had dreadful fits of pain and spasm in the throat whenever she attempted to swallow liquids, also burning and pricking along the course of the gullet, and increase of pain in these parts on pressure. There was likewise frequent vomiting of mucous and bilious matter, with burning pain in the stomach and tenderness of the epigastrium on the slightest pressure. She had farther profuse diarrhœa, with pricking pain and tenesmus. The pulsation of the heart was deep and slow, the pulse at the wrist almost imperceptible, and the breathing much retarded. In eighteen hours these symptoms continued without any material change; but the limbs were also then insensible. In twenty-three hours she died in a fit of fainting, the mind having been entire to the last *.—Orfila's case was that of a gentleman who drank by mistake an alcoholic solution of corrosive sublimate, but fortunately was so much alarmed in the act of swallowing by its taste, that he ceased drinking before he finished the poisonous draught. Nevertheless, he was instantly attacked with a sense of tightness in the throat and burning in the stomach, and soon after with vomiting and purging. Two hours after the accident Orfila found him with the face very full and red, the eyes sparkling and restless, the pupils contracted, and the lips dry and cracked. There was also acute pain along the whole course of the alimentary canal, particularly in the throat. The belly was swelled, and so tender, that he could not bear the weight of fomentation-cloths. The pulse was 112, small and sharp; the skin intensely hot and pungent; micturition scanty, frequent and difficult; the breathing very much oppressed; the purging bilious. The patient had likewise a tendency to doze, and was affected with occasional convulsive twitches of the face and extremities, and with constant cramps in the limbs. Next morning all the symptoms were sensibly mitigated, and they went on decreasing till convalescence was established in eight days. In the course of a few weeks he recovered his usual health, without suffering salivation †.

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* *Houlston* in London Med. Journal, vi. 271.

The only material and common symptom which was wanting in the two cases now related was blood in the stools and in the matter vomited. In other respects they are good examples of the ordinary train of symptoms in cases of the present variety. For other examples of the same nature the reader may refer particularly to the paper of Mr Valentine, who has described five cases that happened at one time in the same family, the mother having attempted to poison herself and four children ‡.

It may sometimes be necessary to know the usual duration of this variety of mercurial poisoning, and also the extremes of its duration. On these points I have not hitherto had opportunities of consulting a sufficient number of cases to be able to lay down the general rule with precision But, so far as my

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* Arch. Gén. de Méd. ix. 463.

† Toxicol. Gén. i. 263.

‡ Edin. Med. and Surg. Journal, xiv. 468.

inquiries go, the ordinary duration in fatal cases is from twenty-four to thirty-six hours. It is probable that a few may last three days *, but only one instance has come under my notice where the duration was greater; and in that instance, which is described by *Dr Venables*, life was prolonged under great agony from pain of the belly, bloody vomiting, diarrhœa and suppression of urine, but without salivation, for no less than eight days †. In cases of recovery the symptoms of irritation may continue very long, and nevertheless not pass into the second variety of this kind of poisoning,—a transition, however, which on the whole is exceedingly common. In the case of which an analysis has been given from Orfila's narrative, and likewise in one of Mr Valentine's patients who recovered, the symptoms all along were those of irritation in the alimentary canal; there was not any ptyalism, or other symptom of the proper mercurial erethysm.—The shortest duration yet recorded is two hours and a-half. This was in a case related by *Dr Bigsby* of Newark-on-Trent, where a tea-spoonful of a concentrated solution of nitrate of mercury was swallowed by a lad sixteen years old, and where the chief symptoms were burning pain from the mouth to the stomach, tenderness of the whole belly, mucous vomiting, and feculent purging ‡. Next to this the shortest case recorded proved fatal in eleven hours §.

2. The second variety of poisoning with mercury comprehends the cases, which begin, like the former, with irritation in the alimentary canal, but in which the symptoms of what is called mercurial erethysm gradually supervene.

It is unnecessary to describe here the several forms of mercurial erethysm which may thus be developed, because they will immediately be considered under the third variety of mercurial poisoning. It is sufficient to remind the reader in passing that the leading affection is inflammation of the organs in and adjoining the mouth, and more particularly of the salivary glands.

But it may be right to endeavour in the present place to fix the period of the poisoning at which these secondary affections may and usually do commence. This cannot be done so satisfactorily as might be wished, because the cases already published which I have been able to examine do not form a large enough induction. Among the recorded cases I have hitherto seen, salivation has never been retarded beyond the third day[*]; but in an instance of suicide by corrosive sublimate which happened in the Castle of Edinburgh in 1826, and for the particulars of which I am indebted to my friend *Dr Shortt* of this city, the salivation did not begin till the fourth. Salivation very seldom comes on sooner than the beginning of the second[†]; and the most usual date of its commencement is towards the close of the second day. There is no doubt that it may be retarded till a period considerably later than I have yet found recorded; but I question whether it ever begins much sooner than after the first twenty-four hours. It has been said, indeed, that ptyalism may supervene when the inflammatory stage has lasted less than that interval; and an instance has been described by *Mr H. Anderson* of Belfast, in which this appeared to him to have taken place only nineteen hours after the poison was swallowed[‡]. Hitherto I have met with no other fact which supports the general statement; and there is some reason for suspecting that Mr Anderson's narrative is not quite correct, and that he mistook for mercurial ptyalism the common salivation caused by inability to swallow from soreness of the throat. (p. 380.) I shall presently, however, mention a singular case of salivation from calomel occurring in the course of a few hours [p. 377.]

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* Mr Valentine's 4th case.

† London Medical Gazette, viii. 616.

‡ Ibidem, vii. 329.

§ Mr Valentine's case 1st.

As to the total duration of this variety in fatal cases, I have found an instance fatal on the fourth day, salivation having begun on the second[§]; and *Orfila* quotes a case from Degner, in which the gastro-enteritic symptoms were succeeded by ptyalism about the same period, and which proved fatal in fifteen days[||]. These periods, however, probably do not form the extremes. For in such cases as the former death is the consequence of the primary affection, and may therefore ensue immediately after the secondary stage has begun to develope itself; and when death arises from profuse salivation as in Degner's patient, or from the ravages committed by ulceration and gangrene, it may be delayed almost as long as in cases of the third variety of mercurial poisoning, in which there is no percursory stage of inflammation in the alimentary canal.

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[*] Case in Med. and Phys. Journal, xli.

[†] Case by Dr Anderson in Edin. Med. and Surg. Journal, vii. 437.

[‡] Edin. Med. and Surg. Journal, xiv. 474.

[§] Lond. Med. and Phys. Journal, xli.

[||] Toxic. Générale, i. 282, from Degneri Historia Med. de Dysent. Bilios. Contag. 250.

The present variety of poisoning with corrosive sublimate may be concluded with the heads of a very excellent example related in the Medical and Physical Journal. The patient, a stout young girl, swallowed soon after supper a drachm of corrosive sublimate dissolved in beer; and in a few minutes she was found on her knees in great torture. All the primary symptoms of this kind of poisoning were present in their most violent form,—burning in the stomach, extending towards the throat and mouth; followed in no long time by violent vomiting of a matter at first mucous, afterwards bilious and bloody; by purging of a brownish, fetid fluid; suppression of urine and much tenderness of the urethra and bladder; small, contracted, frequent pulse, anxious countenance, and considerable stupor, interrupted frequently by fits of increased pain. All these symptoms were developed in four hours. Subsequently the pain in the stomach became much easier, but that in the throat much worse. At length in the course of the second day the teeth became loose, the gums tender, the saliva more abundant than natural; profuse ptyalism and great fetor of the breath ensued, and the patient expired towards the close of the fourth day *.

3. The third variety of poisoning with mercury comprehends all the forms of what is called mercurial erethysm. Without endeavouring to settle the precise meaning of this term, which is now used in rather a vague sense, I shall consider under the present head all the secondary and chronic effects of mercury. These may be caused by any of its preparations, but are most frequently seen as the consequence of its milder compounds, either given medicinally in frequent small doses, or applied continuously to the bodies of workmen who are exposed by their trade to its fumes.

The secondary and chronic effects of mercury are multifari-

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* Lond. Med. and Phys. Journal, xli. 204.

ous enough in reality; but if credit were given to all that has been written and is still sometimes maintained on this subject, almost every disease in the Nosology might be enumerated under the present head; for there is hardly a disease of common occurrence which has not been imputed by one author or another to the direct or indirect operation of mercury. The present remarks, however, will be confined as much as possible to what is well ascertained, and bears on the medical evidence of poisoning with mercury, or is important in regard to medical police. With this view, salivation and its concomitants, the most usual of the secondary effects of mercury, will first be treated of. Some observations will then be made on the shaking palsy, or *tremblement mercuriel*, which is caused by mercury in those who work with it. And in conclusion, a short view will be taken of the other diseases which are more indirectly induced by this poison, as well as of some which have been ascribed to it on insufficient grounds. This being done, the mode of action of the mercurial poisons will be resumed, and a description given of their relative effects when introduced by different channels and in different chemical forms.

Mercurial salivation may be caused by any of the preparations of mercury, and either by a single dose or by frequently repeated small doses. It may be caused by corrosive sublimate as the secondary stage of a case which commenced with inflammation in the alimentary canal; or it may be the first sign of mercurial action, as in the medicinal mode of administering calomel and blue pill. Even in the latter case a single dose, and that not large, may be sufficient to induce ptyalism of the most violent kind. When induced by a single dose it usually commences between the beginning of the second and end of the third day, rarely within twenty-four hours. But an extraordinary case is mentioned by *Dr Bright*, where five grains, put on the tongue in apoplexy and not washed over, excited in three hours most violent salivation, with such swelling of the tongue that scarifications became necessary [*]. It commences with a brassy taste and tenderness of the mouth, swelling, redness and subsequently ulceration of the gums, peculiar fetor of the breath; and at last an augmentation is observed in the flow of the saliva, commonly accompanied with fulness around the lower jaw.

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[*] Reports of Medical Cases, ii. 337.

These symptoms increase more or less rapidly. Sometimes they are very mild; nay, this form of the secondary effects of mercury may consist in nothing else than brassy taste, tenderness of the mouth, redness of the gums and fetor. On the other hand, the symptoms are often very violent, the salivation being profuse, the face swelled so as to close the eyes and almost fill up the space between the jaw and clavicles, the tongue swollen so as to threaten suffocation, the inside of the mouth ulcerated, nay gangrenous; and at times the gangrene extends over the face. It is not uncommon to observe severe and extensive ulceration without particular increase of the saliva.

These local affections are almost always accompanied with more or less constitutional disorder. If severe, they are attended with the symptomatic fever proper to inflammation and gangrene, from whatever cause they spring. But independently of that, mercurial salivation is accompanied and indeed commonly preceded by a constitutional disorder or symptomatic fever of its own, which occasionally exhibits some peculiarities. The mildest affection of the mouth and salivary glands is very generally preceded by some exaltation of the pulse and temperature, and other symptoms of fever. But when the local disorder begins violently, and above all when this takes place by idiosyncrasy from small doses of mild preparations, there is often great rapidity of the pulse, irregular action of the heart, and various nervous disorders possessing the hysteric character,—all of which, except the quick pulse, will sometimes gradually abate or even disappear, when the salivation is fairly established.

As the phenomena of mercurial salivation have been often known to yield important evidence, and have led to a contrariety of opinions upon trials, it will be necessary to dwell on them at some length, at least upon those which it is proper for the medical jurist to know.

In the first instance, then, the dose which is required to bring on salivation may be noticed. It is needless to mention the ordinary quantity required in mercurial courses. A more useful object of consideration is the deviations from the ordinary rule. One of the most common and important of these deviations is excessive sensibility to the action of mercury, in consequence of which the individuals who have this idiosyncrasy may be profusely salivated by one or two small doses even of the mildest preparations. Three grains of corrosive sublimate divided into three doses have caused violent ptyalism [*]. Fifteen grains of blue pill, taken in three doses, one every night, have excited fatal salivation [†]. Nay, two grains of calomel have caused ptyalism, extensive ulceration of the throat, exfoliation of the lower jaw, and death [‡]. Three drachms of mercurial ointment applied externally have caused violent ptyalism and death in eight days. On the other hand, it is well known that some constitutions resist the action of mercurials very obstinately, so as even sometimes to appear incapable of being salivated at all. I have more than once met with cases of the last description, where mercurial courses had been continued for three months and upwards without avail. It may be added, that, except in constitutions naturally predisposed to suffer from a few small doses, a few large doses do not appear apt to excite severe salivation, or even to cause any at all. This has been clearly shown in the course of the practice lately introduced of administering calomel in doses of a scruple. On that subject more will be said by and bye (p. 397.) At present I may mention, that, in conformity with the practice alluded to, I have several times, and in various diseases, given eight or ten grains of calomel five or six times a-day for two or three days together, without observing that ptyalism was apt to ensue.

The next point to be considered is, whether mercurial salivation can be confounded with any other affection. In a very difficult case of poisoning which was tried here in 1817, that of William Patterson for murdering his wife [§], it appeared probable that he had given her repeatedly large doses of calomel. But the proof of this was circumstantial only, and an important circumstance in the chain of evidence was a deposition to the occurrence of salivation during the woman's illness. This fact, however, rested on the skill and testimony of a quack-doctor only; and the admissibility of such a person to decide on a point of this nature, will depend on the facility with which the true mercurial form of salivation can be recognized. This statement will show the practical object of what is to follow.

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[*] M. Colson in Arch. Gén. de Méd. xii. 84.

[†] Dr Ramsbotham in Lond. Med. Gazette, i. 775.

[‡] *Dr Crampton*, Trans. Dublin College of Physicians, iv. 91.

[§] See page 398.

Many other causes may excite a preternatural flow of saliva. Several other poisons may have that effect, for example preparations of gold, preparations of copper, antimony, croton-oil, and foxglove: Foxglove has been known to cause violent salivation for three weeks [*]. Opium has occasionally had the same effect [†].

Even a common sore throat, if the swelling and pain are so great as to render swallowing very difficult and distressing, may be accompanied, as I have often remarked, with a profuse flow of saliva. It is probable that the salivation observed by Mr Anderson in the first day of a case of mercurial poisoning, as formerly mentioned, (p. 375,) was simply produced by the impossibility of swallowing; for he has noticed it only once in his report, and speaks of his patient being quite convalescent in three days; whereas a mercurial salivation, when it takes place early in such cases, is always severe, if the patient survives a few days. In the salivation which is apt to accompany the ulcerative stage of a severe attack of sore throat, there is also often a fetor that is hardly distinguishable from the mercurial kind.

Salivation likewise forms an idiopathic disease, and may then be both profuse and obstinate. *Mr Davies* has described a case of spontaneous ptyalism which had lasted for a fortnight before he was called to see the patient; and during all that time the quantity of saliva discharged was two or three pints daily. How long it endured afterwards he does not mention; but it must have continued for some time, because during his attendance first one physician and then another were called into consultation with him. Laxatives slowly removed it. Mr Davies has not described the state of the mouth; but the first physician mistook the salivation for a mercurial one [‡].—In the same journal which contains this case another has been related which lasted four months [§].—Another and a very remarkable case has been recorded by *Mr Power*. The patient, a young lady, discharged for more than two years from sixteen to forty ounces of saliva daily. In the two last cases the mouth was not affected [‖].—Two other instances have been related by *M. Bayle*, in one of which the patient was cured after spitting five pounds daily for nine years and a-half; while the other continued to be affected after spitting profusely for three years. In neither was there any ulceration of the mouth [*].—Another instance has been related by an Italian physician, *Dr Petrunti*, where, in the course of various nervous affections of the hysteric character, the patient became affected with heat and tightness in the throat, and so profuse a salivation for two months, that between three and four pounds were discharged daily[†].—A case somewhat similar is related in Rust's Magazin of a man who suffered upwards of two years from a daily salivation alternating occasionally with a mucous discharge from the bowels or lungs [‡].—*M. Guibourt* describes the case of a lady who had an attack of profuse salivation every thirty, forty, or fifty days, lasting between twenty-four and forty-eight hours, and unaccompanied with any other affection of the mouth or adjoining parts except a sense of tightness in the throat [§]. I have likewise met with a singular case where spontaneous ptyalism accompanied an ulcerated sore-throat of the mercurio-syphilitic kind. The patient had taken mercury to salivation about six months before coming under my care, and got completely rid of both the sore throat and salivation. But the sore throat returned, together with the salivation, two months before I saw him, and the salivation continued for two months longer to the extent of twenty or even thirty ounces daily,—the ulcer of the throat during that interval being sometimes healed up and again returning as severely as ever. In three weeks more the discharge rapidly diminished, and ceased. During all the time he was under my care there was no fetor of the breath, and no redness, ulceration, or sponginess of the gums.—A singular account of an epidemic salivation which occurred in connexion with a continued tertian fever, has been given in an inaugural dissertation contained in one of Haller's Collections. The author, *Quelmalz*, says that the ptyalism sometimes continued for three weeks, that it was in one instance as great in extent as the most violent mercurial salivation, and that it was accompanied by fetor, superficial ulceration of the mouth, pustules on the tongue, relaxation of the gums, and looseness of the teeth*.

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[*] Rust's Magazin, xxv. 578.

[†] Journal der Praktischen Heilkunde, ix. ii. 201.

[‡] Lond. Med. and Phys. Journal, xxvi. 452.

[§] Ibid. xxvii. 275.

[‖] Trans. Lond. Coll. Phys. i. 34.

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[*] Revue Médicale, 1828, iv. 76.

[†] Ibidem, 1829, i. 467, from Osservatore Medico di Napoli, Febb. 1829.

[‡] *Dr Tott* in Rust's Magazin für die gesammte Heilkunde, xxxv. 50.

[§] Journ. de Chim. Méd. ix. 197.

Salivation may likewise be produced by the influence of the imagination. I have seen a singular example of this. A woman who had a great aversion to calomel was taking it with digitalis for a dropsical complaint. Some one imprudently told her what she was taking; when, although she had used only two grains, she immediately began to complain of soreness of the mouth, salivated profusely, and even put on the expression of countenance of a salivating person. On being persuaded, however, that she had been misinformed, the discharge ceased gradually in the course of one night. Two days afterwards she was again told on good authority that calomel was contained in her medicines, upon which the salivation began again and was profuse. It did not last above twenty-four hours; but the symptoms during that period resembled a commencing mercurial salivation in every thing but the want of fetor and redness of the gums.

In general, mercurial salivation may be easily distinguished from all the preceding varieties by an experienced practitioner. If its progress has been traced from the first appearance of brassy taste and fetor to the formation of ulcers and supervention of ptyalism, no attentive person can run any risk of mistaking it. Its characters are also quite distinct at the time salivation just begins: The fetor of the breath and sponginess and ulceration of the gums at this stage distinguish it from every other affection. But if the state of the mouth is not examined till the ulcers have existed several days, the characters of the mercurial disorder are much more equivocal. They cannot be distinguished, for example, from some forms of idiopathic ulceration of the mouth connected with unsoundness of constitution, and characterized by extensive sloughing, ptyalism, and gangrenous fetor†.

The next point to be noticed regarding mercurial salivation is, that a long interval may elapse after the administration of the mercury has been abandoned, before the effect on the salivary glands and mouth begins,—mercury in small doses being what is called a cumulative poison, or a poison whose influence accumulates silently for some time in the body before its symptoms break forth. *Swédiaur* has met with instances where the interval was several months [*], *Cullerier* with a case in which it was three months [†]. It will at once be seen how strongly such facts may bear on the evidence in a criminal case, where the administration of mercury in medicinal doses, which have been long abandoned, is brought forward to account for salivation, appearing weeks or months after, and giving rise, in conjunction with other circumstances, to a suspicion of mercurial poisoning of much more recent date.

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* De Ptyalismo Febrili. Diss. Inaug. Lipsiæ. in Halleri Disput. de Morb. Histor. i. 469.

† See evidence of *Mr Bromfield* on the Trial of Miss Butterfield for the murder of Mr Scawen, p. 40.

Another question which is sometimes the subject of discussion is the duration of mercurial ptyalism. The medical witness may be required to give his opinion how long this affection may last after the administration of mercury has been abandoned. The present question may be cut short by stating, that there appears to be hardly any limit to its possible duration. *Linnæus* met with an instance of its continuing inveterately for a whole year [‡]; *Swédiaur* says he has known persons languish for months and years from its effects [§]; and *M. Colson* knew an individual who had been salivated for six years [||]. These, however, are very rare incidents. After an ordinary mercurial course the mouth and salivary glands generally return to the healthy state in the course of a fortnight or three weeks.

A fifth question, whether the ptyalism, or, speaking in general terms, the erethysm of mercury is susceptible of a complete intermission, formed a material subject of inquiry, and the cause of much contradicory statement on a well-known criminal trial. At the Trial of Miss Butterfield in 1775 for the murder of her master, Mr Scawen, by administering corrosive sublimate, it was alleged in her defence, that the salivation and consequent sloughing of which he died might have arisen, without the fresh administration of mercury, from the renewal of a previous ptyalism, which had been brought on by a common mercurial course, and had ceased two months before the second salivation began. It appeared that Mr Scawen was salivated with a quack medicine from the beginning till the middle of April, and that about the middle of June he was again seized with violent salivation, of which he died. It was rendered very improbable, that during the interval between the two salivations any more mercury had been taken medicinally. The question then was, whether the original ptyalism could have reappeared after so long an interval without the fresh administration of mercury? The witnesses for the prosecution, gentlemen in extensive practice, said it could not. But one of the prisoner's witnesses, *Mr Bromfield* of the London Lock Hospital, said he had repeatedly known salivation reappear after a long intermission; that it was quite common for the hospital patients to have a second salivation when thought well enough to go out the next dismissal day [*]; that in one case the interval was three months; and that one of his patients was attacked periodically with salivation at intervals of six weeks or a month for a whole year. *Mr Howard*, another surgeon of the Lock Hospital, deposed to the same effect; and the prisoner was acquitted apparently upon their evidence [†].

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[*] Swédiaur on Venereal Diseases, ii. 251.

[†] *Colson* in Arch. Gén. de Méd. xii. 99.

[‡] Flora Suecica.

[§] On the Venereal Disease, ii. 143.

[||] Colson in Arch. Gén. xii. 99.

Notwithstanding what was said by these gentlemen, I believe the recurrence of salivation after so long an interval, without the repetition of mercury, is exceedingly uncommon. *Dr Gordon Smith*, in alluding to the trial of Miss Butterfield, has mentioned a case which he considers the most satisfactory of all he has been able to collect. It occurred to Dr Hamilton of this University, and used to be related by him in his lectures. The interval was so great as four months [‡]. *Dr Mead* says he met with an instance where the interval was six months [§]; and *Dr Male* mentions another where mercury brought on moderate salivation in March, and after a long interval excited a fresh salivation in October, of which his patient died in a few weeks [‖]. Some other cases even more wonderful have been recorded by *M. Colson* in his paper on the effects of mercury. He quotes Dr Fordyce for the case of a man who had repeated attacks of salivation, with metallic taste, which lasted for three weeks, although mercury had not been taken for twelve years; and Colson himself knew a surgeon who had a regular and violent attack of all the symptoms of mercurialism eight years after he had ceased to take mercury [*]. It is impossible to attach credit to such marvellous stories as these last. Granting the ptyalism to be in every instance really mercurial, it would require much better evidence than any practitioner could procure to determine the fact that mercury had not been given again during the supposed interval. This objection indeed will apply more or less even to the instances where the alleged interval did not exceed a few months.

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[*] The exact time is not mentioned.

[†] Trial by Gurney and Blanchard, pp. 39, 47.

[‡] Principles of Forensic Medicine, 2d Ed. 118.

[§] Mead's Medical Works, p. 202.

[‖] Male's Juridical Medicine, 89.

The last point to be noticed regarding mercurial salivation is the manner in which it proves fatal. Death may ensue from the mildest preparations, and from the smallest doses, in consequence of severe salivation being produced by them in peculiar habits. Two instances have been already mentioned which illustrate both of these statements, and others might easily be mentioned, if the fact were not familiar.

Death may be owing to a variety of causes. Some of those which have been assigned are direct and unquestionable in their operation; others indirect and more doubtful.

The most direct and obvious manner in which death takes place is by extensive spreading gangrene of the throat, mouth, face, and neck. The late happy changes, introduced into the treatment of syphilis and other diseases which are benefited by mercury, render this mode of death very rare in the present day. Yet I may mention that I have seen an example of it in a woman who was salivated to death, because her medical attendant, a firm believer in the powers of mercury as an antidote, did not consider that the antidote is itself a poison, if not given in moderation. In general, when gangrene is the cause of death, it begins within the mouth or in the throat, and spreads from that till it even reaches the face. But sometimes it begins at once on the external surface, at a distance from the primary ulcers. An example of such a progress of the symptoms has been related by *Dr Grattan*. A child ten years old was violently salivated by twenty grains of calomel given in six days. On the fifth day of the salivation, a little vesicle appeared on the skin near the mouth on each side, and was the commencement of a gangrenous ulcer, which spread over the whole cheek, and proved fatal eight days after its appearance [†].

[*] Archives Gén. de Méd. xii. 100.

[†] Trans. Dublin Coll. Physicians, iii. 236.

Another cause of death appears to be exhaustion from profuse and protracted discharge of saliva without material injury of the mouth or adjoining organs.

A third manner of death which I have witnessed is exhaustion from laryngeal phthisis; and from the circumstances of the case, I have little doubt but, in the state to which patients are then sometimes reduced, death may also take place suddenly from suffocation. My patient had undergone before I saw him five long salivations for a venereal complaint, and had latterly been attacked with symptoms of ulceration of the glottis. This affection went on slowly increasing, and he died of exhaustion after many weeks of suffering. During this period he was repeatedly attacked with alarming fits of suffocation, which were relieved by the hawking of mucous flakes. The symptoms were explained on dissection by the appearance of extensive ulceration and thickening of the glottis, and almost total destruction of the epiglottis.

The other causes of death are more indirect, and will be mentioned presently. They depend on the pre-existence of other diseases, on which mercury acts deleteriously during the state of erethysm excited by it in the constitution.

The second division of the secondary effects of mercury comprehends the *Shaking Palsy* or *Mercurial Tremors*, with the collateral disorders induced in miners, gilders, and other workmen whose trade exposes them to the operation of this poison. Under the present head, which might be treated at considerable length as an important branch of medical police, I shall confine myself chiefly to an analysis of an interesting essay by *Mérat* on the *Tremblement Metallique*, and to some remarks by *Jussieu* on the health of the quicksilver miners of Almaden in Spain.

Mérat's account of the *Shaking Palsy* induced by mercury is very interesting [*]. The disease, he states, may sometimes begin suddenly; but in general it makes its approaches by slow steps. The first symptom is unsteadiness of the arms, then quivering, finally tremors, the several movements of which become more and more extensive till they resemble convulsions, and render it difficult or impossible for the patient to walk, to speak, or even to chew. All voluntary motions, such as carrying a morsel to the mouth, are effected by several violent starts. The arms are generally attacked first and also most severely. If the man does not now quit work, loss of memory, sleeplessness, delirium, and death ensue. But as the nature of the disease soon renders working almost impossible, he cannot well continue; and in that case death is rare. The concomitant symptoms of the trembling are a peculiar brown tint of the whole body, dry skin, flatus, but no colic, no disorder of respiration, and, except in very old cases, no wasting or impaired digestion. The pulse is almost always slow.—This description agrees perfectly with a somewhat later account of the disease by *Dr Bateman*, as he observed it in mirror-silverers [*]; and also with some interesting cases recently published by *Dr Bright* [†].

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[*] Appendix to his Traité de la Colique Métallique, p. 275.

In general the tremors are cured easily, though slowly, several months being commonly required. One of Dr Bright's patients got almost well in little more than a fortnight under the use of sulphate of zinc. Sometimes, however, the trembling is incurable [‡]. I have said the disease is rarely fatal. Mérat quotes three cases only, in one of which death was owing to profuse salivation and gangrene, in the others to marasmus. On the whole, those who are liable to the shaking palsy do not appear liable to salivation. Yet the two affections are sometimes conjoined, as in three of the cases described by *Dr Bright*, and in some noticed by *Mr Mitchell* among the mirror-silverers of London [§]. Gilders, miners, and barometer-makers are all subject to the disease. Even those who undergo mercurial frictions may have it, according to Mérat; and *M. Colson*, who confirms this statement, quotes Swédiaur as another authority for it [‖]. It is not merely long-continued exposure to mercurial preparations that causes the shaking palsy: A single strong exposure may be sufficient; and the same exposure may cause tremors in one and salivation in another. My friend *Mr Haidinger* the mineralogist has mentioned to me an accident a barometer-maker of his acquaintance met with, which illustrates both of these statements. This man and one of his workmen were exposed one night during sleep to the vapours of mercury from a pot on a stove, in which a fire had been accidentally kindled. They were both most severely affected, the latter with salivation, which caused the loss of all his teeth, the former with shaking palsy, which lasted his whole life.

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[*] Edin. Med. and Surg. Journal, viii. 376, and ix. 180.

[†] Reports of Medical Cases, ii. 495.

[‡] *Fernelius*, de Lues Ven. Curat. c. vii.

[§] London Med. and Phys. Journal, lxvii. 394.

[‖] Arch. Gén. de Méd. xiv. 109.

With regard to all such workmen, it is exceedingly probable that with proper care the evils of their trade may be materially diminished. This appears at least to be the result of the observations made long ago by *Jussieu* on the miners of Almaden in La Mancha. Most quicksilver mines are noted for the mortality among the workmen. But Jussieu maintains that the trade is not by any means so necessarily or so dreadfully unhealthy as is represented, or as it really is in some places. The free workmen at Almaden, he says, by taking care on leaving the mine to change their whole dress, particularly their shoes, preserved their health, and lived as long as other people; but the poor slaves, who could not afford a change of raiment, and who took their meals in the mine, generally without even washing their hands, were subject to swelling of the parotids, aphthous sore throat, salivation, pustular eruptions, and tremors *.

The last division of the secondary effects of mercury relates to its indirect and obscure action in conjunction with other diseases or predispositions to disease.

Of these effects there are some of which the poison appears to be the chief, if not even the sole cause. Thus during the symptomatic fever which precedes salivation there are sometimes remarked imitative inflammations, or coma, or affections of the heart, which go off as the salivation is established.

Other effects require the distinct co-operation of collateral causes. Many inflammatory diseases, not easily excited in ordinary circumstances, arise very readily from improper exposures during salivation, for example dropsy, peripneumony, phrenitis, iritis, erysipelas, and various chronic eruptions.

Other effects again require the co-operation of disease, such as sloughing gangrene supervening on ordinary ulcers during the action of mercury,—a very common accident. This appears most likely to happen when the ulcers are constitutional.

Lastly, in conjunction with other diseased morbid actions either going on at the same time, or immediately preceding mercurial erethysm, this poison is apt to occasion some modifications of disease which are rarely otherwise witnessed. Modifications of the kind have already been traced in the instances of lues venerea and scrofula; but there is reason to believe that the same singular property may also exist in relation to other constitutional disorders.

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* Mém. de l'Acad. des Sciences, 1719, p. 474.

These observations conclude the inquiry into the symptoms caused in man by mercurial poisons generally. Returning now to its mode of action we have to examine its relative effects through the different animal textures, and in its various chemical forms.

The result of the previous remarks as to its action on animals, it will be remembered, was, that its soluble preparations cause when swallowed corrosion of the stomach, and in whatever way it enters the body irritation of the stomach and rectum, inflammation of the lungs, depressed action and perhaps inflammation of the heart, oppression of the functions of the brain, inflammation of the salivary glands. All of these effects have likewise been mentioned in the preceding sketch, as occurring in a greater or less degree in consequence of its operation on man.

Mercury acts as a poison on man in whatever way it is introduced into the body,—whether it is swallowed, or inhaled in the form of vapour, or applied to a wound, or even simply rubbed or placed on the sound skin. But the kind of action excited differs according to the channel by which it is introduced.

The most ordinary and dangerous cases of poisoning arise from the introduction of corrosive sublimate into the stomach. The poison then kills by corroding or inflaming the alimentary canal, or by causing salivation and its concomitants.

When applied to a wound or ulcer corrosive sublimate does not often occasion dangerous symptoms. Yet it is sometimes a hazardous remedy. It is not a convenient escharotic even in a concentrated state; for its escharotic action is not incompatible with its absorption; at all events it certainly sometimes acts constitutionally through the surface of wounds and ulcers, and the symptoms brought on in this way are generally violent.

They are the symptoms of mercurial salivation, accompanied at times with well-marked inflammation of the alimentary canal. When applied to sores in a diluted state it has also been known to cause dangerous effects if too long persevered in. A case of the kind has been related by *Mr Robertson*, an army-surgeon. After anointing an itchy eruption of the arms for seven days with a solution of corrosive sublimate containing five grains to the ounce, his patient was attacked with fever, inflammation of the stomach and bowels, and in two days more with violent salivation [*]. A case of the same nature has been related by *Mr Sutleffe* [†]. His patient, a child, in consequence of having an eruption of the head washed with a solution of corrosive sublimate, was attacked with violent salivation, which proved fatal in a few days. *Pibrac* has recorded three fatal cases from the free application of corrosive sublimate to ulcerated surfaces. One of these proved fatal in five days, another in twenty-four hours, and the third during the night after the poison was applied. The symptoms generally indicated violent action on the alimentary canal [‡]. In an instance mentioned by *Degner*, fatal in twenty-five days, there was also violent irritation of the stomach; but the chief affection was excessive swelling of the face and throat, together with profuse ptyalism [§].

One of the readiest modes of bringing the system under the poisonous action of mercury is by introducing its preparations into the lungs. It appears from some experiments by *Schlöpfer* that the fluid preparations act rapidly through the lining membrane of the air-passages. Six grains of corrosive sublimate in solution will thus kill a rabbit in five minutes [‖]. But the effects of mercury through this channel are much better exemplified when its preparations are inhaled in the form of vapour. Corrosive sublimate when incautiously sublimed in chemical experiments has been often known to cause serious effects. *Dr Coldstream* of Leith informs me, that while subliming about twenty-four grains of it with the blowpipe when a student he and several of his fellow-apprentices were seized with painful constriction of the throat, several had headach, and one had sickness and vomiting. The phenomena produced by the various preparations of mercury in more violent cases, are sometimes protracted tremors [*], sometimes severe ptyalism and protracted dysentery [†], sometimes salivation and gangrene of the mouth ending fatally [‡]. This last form was produced very remarkably in a chimney-sweeper, after cleaning a gilder's chimney, during which operation he felt a disagreeable sense of tightness in the throat.

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[*] Edin. Med. and Surg. Journal, viii. 195.

[†] London Medical Repository, xvi. 458.

[‡] Mémoires de l'Acad. de Chirurgie, iv. 154.

[§] *Wibmer*. Die Wirkung der Arzneimittel und Gifte, iii. 46.

[‖] Diss. Inaug. de Effectibus Liquidorum in vias aeriferas applicitorum, p. 35.

Several extraordinary instances have happened of poisoning from long-continued inhalation of the vapours which arise from metallic mercury. That vapours do arise from metallic mercury at the ordinary temperature of the atmosphere has been fully proved by *Mr Faraday*, who found, that when a bit of gold was suspended from the top of a phial, the bottom being covered with a little mercury, the gold soon became amalgamated [§]. The vapours thus discharged may produce the worst species of mercurialism, if they are diffused through an apartment insufficiently ventilated. One of the most striking examples known of the baneful effects of mercury thus gradually insinuated into the system occurred in the well-known accident which befel his Majesty's ships Triumph and Phipps. These vessels were carrying home in 1810 a large quantity of quicksilver saved from the wreck of a ship near Cadiz, when by some accident several of the bags were burst and the mercury spilled. On the voyage home the whole crews of both vessels were more or less severely salivated, two died, many were dangerously ill, all the copper articles on board became amalgamated, all the rats, mice, cock-roaches, and other insects, as well as a canary-bird and several fowls, and all the larger animals, such as cats, dogs, goats, and sheep were destroyed [‖].

The action of mercury is often violently excited when it is applied to the skin even not deprived of the cuticle. The effects of mercurial inunction form a well-known and satisfactory with running quicksilver, will act as a mercurial when rubbed upon the skin. Here too, however, some oxidation takes place in the making of the ointment. On this subject a valuable essay was published some years ago by *Mr Donovan*, who makes it appear, that the protoxide of mercury may be always found in blue ointment, and that, although its proportion is very small, compared with the mercury which is not oxidated, the oxide nevertheless is the only active ingredient *.

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[*] Hufeland's Journal, xlii.

[†] Mr Hill in Edin. Med. Ess. iv. 38.

[‡] Corvisart's Journal, xxv. 209.

[§] London Journal of Science, x. 354.

[‖] Edin. Med. and Surg. Journal, vi. 513, and London Medical and Physical Journal, xxvi. 29.

It has been farther said, in proof of the poisonous action of quicksilver in its metallic state,—that patients, who have taken it for obstructed bowels, have sometimes been salivated. This accident has, I believe, happened in a few instances where the mercury was retained long in the body. But such cases are undoubtedly very rare. *Zwinger* mentions the case of a man, who took four ounces for colic, and was seized in seven days with salivation †. And *Laborde* relates the particulars of another instance where seven ounces taken in fourteen days excited ptyalism, ulceration of the mouth, and great feebleness of the limbs ‡. Perhaps then it must be admitted that fluid mercury is not altogether inactive, speaking medico-legally. But this admission is no argument in favour of the metal being physiologically a poison; because in the course of the cases referred to, a part is in all likelihood oxidated by the oxigen in the intestinal gases.

The question regarding the poisonous qualities of running quicksilver seems to have been fully set at rest by the Berlin College of Physicians in a report on the case in Pyl's Repertory §. They observe that the opinion of *Pliny*, *Galen*, *Hippocrates*, *Dioscorides*, and many of the earlier moderns, including even *Zacchias*, had led to the popular belief in the deadly properties of fluid mercury; but that this belief is erroneous; for many surgeons, and among the rest *Ambrose Paré*, had given without injury to their patients several pounds of it to cure obstructed bowels; and in 1515 the Margrave of Brandenburg, overheated on his marriage night with love and wine, and rising to quench his thirst, drank by mistake a large draught of quicksilver without suffering any harm. *Fallopius* mentions that he had known instances of women swallowing pounds of mercury, for the purpose of procuring miscarriage, and who did not suffer any injury [*].

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* Annals of Philos. xiv. 241, 321.

† Acta Naturæ Curiosorum, Dec. ii. Ann. vi. Obs. 231.

‡ Journal de Médecine, l. 3.

§ I. 240.

The sulphurets of mercury, like the metal, are not possessed of any deleterious action on the animal body. *Orfila* has very lately found, that half an ounce of the sulphuret, formed in a solution of corrosive sublimate by sulphuretted-hydrogen, and half an ounce or six drachms of cinnabar, had no effect whatever on dogs [†]. The sulphurets which have appeared injurious in the hands of *Smith* [‡] and other previous experimentalists must therefore have been impure.

Of the compounds of mercury, the Red Precipitate and Turbith Mineral act as irritants, besides possessing the property common to all mercurial compounds, of causing mercurial erethysm. But they are not escharotics, though generally termed such. That is, they do not chemically corrode the animal textures. A case of poisoning with Red precipitate is related by *Mr Brett* of London, where the symptoms were occasional vomiting, stupor, languid pulse, cold clamminess of the skin, afterwards severe cramps of the legs, tenderness of the abdomen, dysuria, and some purging, and on the third day ptyalism; but the patient recovered [§]. Two scruples of Turbith mineral will kill a cat in four hours and a-half; and several instances of violent and even fatal poisoning with it are mentioned by the older modern authors [‖].

The White Precipitate or chloride of mercury and ammonia is probably also irritant, though inferior in power to the preparations just mentioned. Two scruples given to a dog will occasion vomiting, pain and some diarrhœa; and cases are recorded of death in the human subject from less doses [¶]. But there are no recent facts as to the activity of this compound, and the older cases which would seem to assign to it very great energy are open to the objection that this preparation was in former times often impure.

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[*] Opera Omnia, p. 729.

[†] Arch. Gén. de Médecine, xix. 330.

[‡] Sur l'usage et les Abus des Caustiques. Paris, 1817. Quoted by *Wibmer*. Smith found two drachms kill a dog when swallowed, and half a drachm proved fatal in two dogs when applied to a wound.

[§] London Medical Gazette, xiii. 117.

[‖] *Wibmer*. Die Wirkung der Arzneimittel und Gifte, iii. 66.

[¶] Ibidem, iii. 647.

The Bichloride or Corrosive sublimate is a powerful corrosive or irritant, according to the dose and state of concentration; and it also excites mercurial erethysm in a violent degree. The Nitrates are also corrosive.

The Cyanide or Prussiate of mercury, from the researches of *Ollivier*, and an interesting case he has published of poisoning with it in the human subject, appears to resemble corrosive sublimate closely in all its effects, except that it does not corrode chemically. Twenty-three grains and a half proved fatal in nine days*.

The Protochloride or calomel, and probably also the protoxide, are the most manageable of the preparations of mercury for inducing ptyalism. Calomel is also an irritant; that is, it causes irritation and inflammation in the alimentary canal when swallowed. This part of its properties as a poison will require a word or two of explanation.

Calomel is universally employed as a laxative, but to secure this effect being produced it is commonly combined with other purgatives. When given alone a few grains will in some constitutions induce a violent hypercatharsis; and larger, but still moderate, doses have with most people such a tendency to cause severe griping and diarrhœa as to have led to the practice of combining it with opium when the object is to salivate. These considerations clearly establish that calomel in a moderate dose, for example five grains, is an irritant.

It farther appears that in larger doses it has occasionally produced very violent effects, nay, even death itself by its irritant operation. *Hoffmann* has mentioned two instances where fifteen grains of calomel proved fatal to boys between the ages of twelve and fifteen. One of them had vomiting, tremors of the hands and feet, restlessness and anxiety, and died on the sixth day. The other, he merely mentions, died after suffering from extreme anxiety and black vomiting†. Another fatal case has been related by *Ledelius* in the German Ephemerides, which was caused by a dose of half an ounce taken accidentally. Vomiting soon ensued and a sense of acridity in the throat; then profuse diarrhœa to the extent of twenty evacuations in the day; next excessive prostration of strength and torpor of the external senses; and death took place in little more than twenty-four hours [*]. *Wibmer* quotes *Vigetius*, an author of the beginning of last century, for a similar case, likewise fatal, which was occasioned by half an ounce,—also *Hellweg*, a writer of the previous century, for the case of a physician, who took an ordinary medicinal dose by way of experiment, and died in five hours under all the symptoms of violent irritant poisoning [†]. The only recent case I have met with where a very large dose of calomel was taken is that of a lady mentioned by *Wibmer*, who took by mistake the enormous quantity of fourteen drachms. Acute pain in the abdomen ensued, together with frequent vomiting and purging; which, however, were speedily subdued by oleaginous demulcents. Smart salivation followed; but in three weeks she recovered entirely. [‡]

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* Arch. Gén. ix. 102.

† De Medicamentis insecuris et infidis, in Oper. Omn. vi. 314.

These observations being kept in view, what explanation will the toxicologist give of the effects which in modern times have been ascribed to large doses of calomel? It was stated not many years ago by several East India surgeons, apparently with the universal assent of all their brethren in later times, that this drug in the dose of a scruple administered even several times a-day, is not only not an irritant, but even on the contrary a sedative [§]; and that in some diseases, for example yellow fever, it has been given in the dose of five, ten, or twenty grains, four or six times a-day, till several hundred grains were accumulated in the body, yet without causing hypercatharsis, nay, with the effect of checking the irritation which gives rise to black vomit in yellow fever, and to the vomiting and diarrhœa observed in the cholera of the East. It is quite impossible for a European physician to deny these statements of his eastern brethren; for all practitioners in hot climates concur in them to a man, and now that analogous practices have been transferred to Britain, repeated opportunities have occurred for establishing the fidelity of the original reporters. I have myself several times tried the method in question; and, even although the calomel was not combined with opium, I never saw it cause diarrhœa or even any material pain, or in short any physiological effect whatever. Some American physicians, improving on the Hindostan treatment, have lately given calomel in bilious fever in the dose of forty grains, one drachm, two drachms, and even three drachms, repeatedly in the course of twenty-four hours for several days together,—and with similar phenomena. In one instance 840 grains were given in the course of eight days in these enormous doses. The largest dose was three drachms; and it was followed by only one copious evacuation, and that not till after the use of an injection *. This practice appears not to have been altogether unknown in former times. *Ledelius*, the author formerly quoted, states, that he had been accustomed to give doses of a scruple, and that Zwölffer even gave a drachm in one dose †.

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[*] Miscellanea Curiosa, 1692. Dec. ii. Ann. x. p. 34.

[†] Die Wirkung der Arzneimittel und Gifte, iii. 72.

[‡] Ibidem.

[§] Johnson on Tropical Climates, pp. 45, 151, 267.—Annesley on the Diseases of India.—Musgrave on Mercury, in Edin. Med. and Surg. Journ. xxviii. 42.

It is impossible in the present place to enter into the physiological action of calomel as a remedy; but every one must be satisfied that, with all which has been already written, much still remains to be done before the facts now mentioned can be explained satisfactorily. Can the violent effects described by Hoffmann, Ledelius and Hellweg have arisen from the calomel having been imperfectly prepared and adulterated with a little corrosive sublimate?

Meanwhile, taking the facts as they stand, it is plain that much greater caution must be used than formerly in ascribing irritant properties generally, or even symptoms of irritant poisoning in a particular case, to large doses of calomel.

With the view of illustrating the importance of the preceding observations, it may be useful to mention here the heads of a case already briefly alluded to for another purpose, the trial of William Paterson for murder (379) ‡. His wife during the month previous to her death had two attacks of diarrhœa, with an interval of a fortnight between them. On the second occasion it became profuse and exhausting, but without any material pain or considerable vomiting; looseness of the teeth and salivation ensued; and she died in nine days. On examination of the body, the anus was found excoriated, the whole intestines checkered with dark patches, and the stomach red, ulcerated, and spotted with black, warty excrescences; but the late Dr Cleghorn of Glasgow could not detect any poison by chemical analysis. It was proved that the prisoner, besides procuring, a few months before his wife's death, a variety of poisons, such as muriatic acid, cantharides, and arsenic, had also on different occasions during her last illness purchased in a suspicious manner four doses of calomel varying from 30 to 60 grains each. Among the various ways in which he was charged with having poisoned the deceased, that which was best borne out by the general as well as medical facts consisted in his taking advantage of an existing inflammation of the mucous membrane of the bowels,—whether arising from a natural cause or from poison it was in this view of the case immaterial to inquire,—and keeping up and aggravating the inflammation by purposely administering at intervals large doses of calomel. On the trial Dr Cleghorn and other witnesses gave their opinion that the doses purchased by the prisoner, if administered, would cause the symptoms and morbid appearances observed in the case. On the other hand, the late Dr Gordon deposed to the effect, that all the symptoms of the case might arise under the operation of natural disease, and that such doses of calomel were by no means necessarily injurious; the late Mr John Bell deposed, that it had even been given in much larger doses without injury; and the profession are now well aware, though not at the time of this trial, that in the very malady alleged by the prisoner to have carried off the deceased, namely dysentery, the administration of calomel in repeated large doses is accounted by many a proper method of cure. The doses purchased by the prisoner were considerably larger, it is true. But there was not any evidence of his having administered his purchases in single doses as he got them; and even though there had been evidence to that effect, it would not remove altogether the difficulty of deciding the question, as to the irritating action of calomel, on which the issue of the trial in one view of the case chiefly depended.

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* *Dr Fletcher.* American Journal of the Med. and Phys. Sciences, vii. 561.

† Miscellanea Curiosa. l. c.

‡ For the documents in this trial I am indebted to my late colleague *Dr Duncan Junior*, who was concerned in it.

It is probable that all the compounds formed by corrosive sublimate with animal and vegetable substances are either not poisonous, or at least very much inferior in activity to corrosive sublimate itself. This has been shown by *Orfila* to be the case with the compound formed by albumen. Sixty grains of the protochloride of mercury and albumen, equivalent to nearly five grains of corrosive sublimate, produced no bad effect whatever on a dog or a rabbit [*]. The same has been satisfactorily proved by *Taddei* as to the compound formed by gluten. Twelve grains of corrosive sublimate decomposed by his emulsion of gluten had no effect whatever on a dog [†]. It is important to remark, however, that if there is an excess of the decomposing principle, so that the precipitate is partly redissolved, the irritant action of the corrosive sublimate is not so much reduced, though it is still certainly diminished. Orfila has settled this point in regard to albumen [‡]. The power of producing mercurial erethysm is possessed by all mercurial compounds whatever, and among the rest by the compounds now under consideration. For it is possessed by the protochloride of mercury and gluten, which, from the experiments of Taddei, appears to be the least active of them all. [§]

The present section may now be concluded with a few remarks on the strength of the evidence derived from the symptoms which are produced by the compounds of mercury.

If the medical jurist should meet with a case of sudden death like that of the animals experimented on by Mr Brodie, the symptoms alone could not constitute any evidence of poisoning with corrosive sublimate. All he could say would be that this variety of poisoning was possible, but that various natural diseases might have the same effect. This feebleness in the evidence from symptoms, however, is of little moment; because the dose must be great to cause such symptoms, and little can be vomited before death; so that the poison will be certainly found in the stomach.

Should the patient die under symptoms of general irritation in the alimentary canal, poisoning may be suspected. But it would be impossible to derive from them more than presumptive evidence. The suspicion must become st if the ordinary signs of irritation in the aliment tended with the discharge of blood upwards a And the presumption will, I apprehend, approa certainty,—at least of the administration of som poison,—if, at the moment of swallowing a su and but a short time before the symptoms of i in the stomach and bowels, the patient should h strong, acrid, metallic taste, and constriction or throat.

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[*] Toxicol. Gén. i. 310.

[†] Recherches sur un Nouvel Antidote contre le sublimé corrosif, p. 34.

[‡] Toxicol. Gén. p. 311.

[§] Recherches, &c. p. 92.

When upon all these symptoms salivation is su evidence of poisoning with corrosive sublimate soluble salt of mercury is almost unequivocal. something has been taken which tasted acrid, and of heat, pricking, or tightness in the throat, th signs of poisoning with the irritants make thei the usual time, and are soon after accompanied true mercurial salivation,—it may be safely infe soluble compound of mercury has been taken. I this inference, however, it will be necessary to precision all the classes of symptoms, more parti ture of the salivation. It should also be remen livation may accompany or follow the symptom tion in the stomach, in consequence of calomel ha as a remedy. But if proper attention be paid in the way of judgment, I conceive that an opini tion of poisoning with corrosive sublimate may rested on the symptoms alone. This is another e rule laid down by almost all modern toxicologis jurists respecting the validity of the evidence of symptoms.

For a good example of the practical applicatio cepts, the reader may consult the Trial of Mr H tempting to poison his wife. In the instance whi the trial in question the patient complained of a ing sensation in the throat during the act of sw pills; in the course of ten minutes violent vomiti terwards severe burning pain along the whole gullet down to the stomach, next morning dia the third day ptyalism. There were many other dical evidence which left no doubt that corrosive sublimate was swallowed in the pills. But even the history of the symptoms alone would have led to that inference [*].

SECTION III.—*Of the Morbid Appearances caused by Mercury.*

The morbid appearances observed in the bodies of persons killed by corrosive sublimate will not require many details; since most of the remarks formerly made under the head of the pathology of the irritants generally, and of arsenic in particular, are applicable with equal force to the present species of poisoning. Still there are some peculiarities which deserve notice, and which arise from the greater solubility or stronger irritant action of corrosive sublimate.

The mouth and throat are more frequently affected than by arsenic; and a singular appearance sometimes remarked, and not excited, so far as I know, by arsenic, is shrivelling of the tongue, with great enlargement of the papillæ at its root [†].

The disorder of the alimentary canal is also usually more general, and reaches a greater height before death takes place. Sometimes the irritation and organic injury are confined to the stomach [‡]; but more commonly the throat, stomach, gullet, rectum, nay even also the colon, are affected. The black or melanotic extravasation into the mucous membrane of the stomach, which has been already several times described as a common effect of the more violent irritants, is often produced by corrosive sublimate. In Devergie's case and in that of Dr Venables it was present to a very great degree [§].

The coats of the stomach, and also those of the intestines, more particularly the colon and rectum, have frequently been found destroyed. So far as I have been able to ascertain, two kinds of destruction of the coats may be met with,—corrosion and ulceration.

The first is the result of chemical decomposition of the tissues. This kind is evidently to be looked for only when the quantity has been considerable and the dose concentrated. Nay even then it is rare. For on account of the solubility of corrosive sublimate, the facility with which it is decomposed by the secretions or accidental contents of the stomach, and the violence and frequency of the vomiting, this poison is peculiarly liable to be prevented from exerting its corrosive action on the membranes. Hence it is that proper chemical corrosion of the coats of the stomach is seldom witnessed in man.

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[*] Edin. Med. and Surg. Journal, xxii. 438.

[†] As in Devergie's Case (Arch. Gén. ix. 468,) in which they were as big as peas.

[‡] Ibidem.

[§] Ibidem.

The appearance of chemical corrosion differs according to the rapidity of the poisoning. In very rapid cases, for example in the animals killed by Mr Brodie, which seldom outlived twenty-five minutes, the villous coat has a dark-gray appearance, without any sign of vital reaction *. But this variety has never been witnessed in man, where the cases have been hitherto much less rapid. In the most rapid cases, such as that of Dr Bigsby, which terminated in two hours and a-half [374], or those related by Mr Valentine, of which one ended fatally in eleven and another in twenty-four hours, the corrosion was black, like the charring of " leather with a red-hot coal, and the rest of the stomach scarlet-red or deep rose-red;—showing that inflammation had set in." In the former of these two cases the corrosion was as big as a half-crown, in the latter three inches in diameter. In a third case, where the patient lived thirty-one hours, the stomach was perforated †. In the case described by *Dr Venables*, which was formerly alluded to, and where life was prolonged for eight days, there was a patch on the under surface of the stomach as large as two crown-pieces, hard, elevated, and of a very dark olive or almost black colour, besides very general erosion of the villous coat ‡. In all these cases the disintegrated spot was probably situated where the chief part of the poison first lodged.

When the poisoning is slow, the disorganized matter sloughs away, leaving an ulcerated cavity. But this does not happen very rapidly; for in Mr Valentine's fourth case, that did not prove fatal for seventy hours, the slough was not entirely removed; and it was also obviously remaining after eight days in the case by Dr Venables.

The corrosion caused by mercury, if examined before the slough is thrown off, will be found to possess an important peculiarity: The disorganized tissue yields mercury by chemical analysis. *Professor Taddei* has repeatedly ascertained the existence of mercury in the membranes of animals which he had poisoned with corrosive sublimate [*]. On this point two rules may be laid down, by means of which corrosions of the kind may be distinguished from most forms of spontaneous erosion. On the one hand, if death takes place too soon for reaction to have begun, the injured membrane will not have sloughed away, and yields mercury by analysis; and it is important to remember, that when the slough is of moderate size, it is often very slowly detached. If, on the other hand, in consequence of life having been prolonged for some time, the disorganized part has sloughed off and been discharged by vomiting, it is probable that mercury will no longer be found; but then the ulcer left is distinguished from most varieties of spontaneous erosion by unequivocal signs of surrounding reaction [†]. From what has just been said of Mr Valentine's cases, it would appear that reaction begins very soon; and this is farther exemplified in the case described by *Dr Bigsby* [p. 374] of poisoning with the nitrate of mercury. Death took place in two hours and a half only; but nevertheless the whole villous coat was deep rose-red in colour, interspersed with livid broad patches, some of which consisted of a soft brownish pulp, on the removal of which the membrane was found eroded [‡].

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* Philos. Trans. 1812.

† Edin. Med. and Surg. Journ. xiv. 472, 473.

‡ London Medical Gazette, viii. 618.

Although it is sometimes possible to find the poison in the stomach, the medical jurist must not perhaps expect to find it so often in the present instance as in that of poisoning with arsenic. For on account of its greater solubility corrosive sublimate cannot adhere with such obstinacy to the villous coat, and is therefore more subject to be discharged by vomiting. Nevertheless, the insoluble compound formed by antidotes may adhere to the coats like arsenic, and so resist the tendency of vomiting to displace them; and this effect of vomiting will be still more effectually resisted when extensive sloughs have been formed and are not detached. In *Devergie's* case, notwithstanding twenty-three hours of incessant vomiting, although no poison could be detected in the fluid contents of the stomach, it was distinctly found in small whitish masses that lay between the folds of the rugæ[*]; and in the remarkable case described by *Dr Venables*, it was found in the tissue of the stomach, although the person survived eight days.

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[*] Recherches sur un Nouvel Antidote, &c. p. 61.

[†] The reader may apply these statements to what has been already said on the trial of Mr Angus under the head of Spontaneous Perforation, p. 133.

[‡] London Medical Gazette, vii. 331.

It may here be observed that corrosive sublimate, as well as the other salts of mercury, may undergo in the alimentary canal after death the same change which is produced in arsenic from the gradual action of sulphuretted-hydrogen gas. It may be converted into the sulphuret. I am not acquainted indeed with any actual instance of such conversion; but that it may occur we can scarcely doubt, not merely from theoretical considerations, but likewise because *Orfila* has met with an instance where calomel taken daily in a case of gastro-cephalitis was discharged by stool in the form of a black sulphuret[†].

Another important consideration is, that corrosive sublimate may be decomposed and reduced to the metallic state by the admixture of various substances either given at the same time or subsequently, and the longer the inspection is delayed, the more complete will be the decomposition which is accomplished. Iron, zinc, and other metals are the most active of these substances[‡].

The other form of destruction of the coats of the alimentary canal is common ulceration, either such from the beginning, or what was originally corrosion converted into an ulcer in consequence of the disorganized spot being thrown off by sloughing.

I have seen this appearance to an enormous extent in the great intestines of a man who survived nine days. Numerous large, black, gangrenous ulcers, just like those observed in bad cases of dysentery, were scattered over the whole colon and rectum. In this instance, for which I am indebted to *Dr Shortt*, the stomach was also ulcerated, but the small intestines were not.

All the other effects of inflammation may be produced by corrosive sublimate, as by arsenic and other irritants. More frequently here than in the case of arsenic peritonæal inflammation is met with. In *Devergie's* case the external surface of the stomach along both its curvatures presented the appearance of red points on a violet ground. In *Mr Valentine's* cases there was much minute vascularity, not only of the outside of the stomach but also of the whole peritonæum lining the viscera and inside of the abdomen; and there was even some serous effusion into the cavity. In *Dr Venables'* case the peritonæal coat of the stomach was highly vascular and inflamed, and the omentum also injected.

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[*] Archives Gén. de Méd. ix. 470.

[†] Journal de Chim. Médicale, viii. 268.

[‡] *Orfila*, Traité de Médecine Légale, iii. 134.

The urinary organs, and particularly the kidneys, are often much inflamed by poisoning with corrosive sublimate. *Dr Henry* of Manchester has related a case in which this poison proved fatal on the ninth day, and where the left kidney was found to contain an abscess *. In all of *Mr Valentine's* cases the kidneys were inflamed, and the bladder excessively contracted, so as not to exceed the size of a walnut. In *Ollivier's* case, caused by the cyanide of mercury, the scrotum was gorged and black, the penis erected, and the kidneys a third larger than natural. In the case described by *Dr Venables* both kidneys, but especially the left, were large, flaccid, and vascular, the ureters turgid and purple, and the bladder contracted, empty, and red internally.

Orfila has observed that the internal membrane of the heart is sometimes inflamed and checkered with brownish black spots. Some remarks have been already made on the light in which this appearance ought to be viewed by the pathologist (p. 320).

Whatever may be the real state of the fact as to the alleged power of arsenic to preserve from decay the bodies of those poisoned with it, all authors agree that corrosive sublimate possesses no such property. Yet it is well known to be a very good antiseptic, when applied topically. The experiments of *Klanck* noticed under the head of Arsenic prove that corrosive sublimate at all events does not retard putrefaction in the bodies of those poisoned with it; and *Augustin* in his analysis of Klank's researches infers that it even promotes decay †. I have met with one example in the human subject which seems to confirm Augustin's opinion. In the case formerly quoted from the Medical and Physical Journal, which was fatal in four days, the relater found the body forty-two hours after death so putrid, though in the month of January, that the examination of it was very unpleasant, the belly being black, and a very offensive odour being exhaled *. Little importance, however, can be attached to a solitary case; for on the contrary *Sallin* relates a case where the body of a man supposed to have been poisoned with corrosive sublimate was found not decayed, but imperfectly mummified, after sixty-seven days †.

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* Edin. Med. and Surg. Journal, vii. 151.

† Augustin's Repertorium, B. i. H. ii. 11.

It is unnecessary to detail the proofs to be found in the dead body of mercurial salivation having existed during life. They are of course to be looked for in the mouth, and in the adjoining organs. We must not, however, expect to see much appearance of disease in the salivary glands; for according to *Cruveilhier*, in persons who die of mercurial salivation these glands do not present any trace of inflammation themselves, although there may be great serous effusion into the cellular tissue around them ‡.

Professor Orfila has made some useful experiments on the effects of corrosive sublimate on dead intestine, which it may be proper to notice in a few words. When applied in the form of powder to the rectum of an animal newly killed, the part with which it is in contact becomes wrinkled, and as it were granulated, harder than natural, and of alabaster whiteness, intermingled with rose-red streaks, apparently the ramifications of vessels. When the membrane is stretched upon the finger, the wrinkling disappears. The muscular coat is of a snow-white colour, and even the serous coat is white, opaque, and thickened. The parts not in contact with the powder retain their natural appearance, and the line of demarcation between the affected and unaffected portions is abrupt. If the powder is not applied till twenty-four hours after death, the parts it touches become thick, white, and hard; but no red lines are visible. It is easy to draw the line of distinction between these appearances and the effects of corrosive sublimate during life.

Little need be said of the force of the evidence of poisoning with corrosive sublimate, derived from the morbid appearances. If the gullet, stomach, and colon be all inflamed and ulcerated, and these injuries have taken place during a short illness, the presumption in favour of some form of irritant poisoning will be strong. And the presumption of poisoning with corrosive sublimate will be strong, if the usual marks of salivation are also found in the mouth and throat. But such evidence can never amount to more than a strong presumption or probability.

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* xli. 207.

† Journal de Médecine, l. iii. 15, or Recueil Périodique de la Soc. de Méd. vii. 343.

‡ Revue Médicale, 1830, ii.

SECTION IV.—*Of the Treatment of Poisoning with Mercury.*

The treatment of poisoning by the compounds of mercury may be referred to two heads,—that which is required when irritation of the alimentary canal is the prominent disorder, and that which is calculated to remove mercurial salivation.

Irritation and inflammation of the alimentary canal are to be treated nearly in the same way as when arsenic has been the poison swallowed. But in the instance of corrosive sublimate we possess, what is much wanted in poisoning with arsenic, a convenient and effectual antidote.

Several substances may be used as antidotes; but those which have hitherto been most employed are albumen and gluten.

It has been already hinted that albumen, in the form of white of eggs beat up with water, impairs or destroys the corrosive properties of the bichloride of mercury, by converting it into a protochloride of mercury and albumen. For this discovery and the establishment of albumen as an antidote, the physician is indebted to *Professor Orfila*. He has related many satisfactory experiments in proof of its virtues. The following will serve as an example of the whole. Twelve grains of corrosive sublimate were given to a little dog, and allowed to act for eight minutes, so that its usual effects might fairly begin before the antidote was administered. The white of eight eggs was then given; after several fits of vomiting the animal became apparently free from pain; and in five days it was quite well [*]. According to *Peschier* the white of one egg is required to render four grains of the poison innocuous [†]. The experiments of the Parisian toxicologist have been repeated and confirmed by others and particularly by *Schloepfer*; who found that when a dose was given to a rabbit sufficient to kill it in seven minutes if allowed to act uncontrolled, the administration of albumen, just as the signs of uneasiness appeared, prevented every serious symptom *.

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[*] Toxicologie Générale, i. 313.

[†] *Corvisart's* Journal de Médecine, xxxviii. 77.

Its virtues have also been put to the proof in the human subject with equally favourable results. The recovery of the patient, whose case was quoted formerly (p. 373,) from Orfila's Toxicology, seems to have been owing in great measure to this remedy. In the Medical Repository another case is related, in which it was also very serviceable †. A third very apposite example of its good effects is related by *Dr Lendrick.* His patient had taken about half a drachm of corrosive sublimate, and was attacked with most of the usual symptoms, except vomiting. The white of eggs was administered a considerable time afterwards, the beneficial effects of which were instantaneous and well marked; and the patient recovered ‡. A few years ago Orfila's discovery was the means of saving the life of *M. Thenard* the chemist. While at lecture, this gentleman inadvertently swallowed, instead of water, a mouthful of a concentrated solution of corrosive sublimate; but having immediately perceived the fatal error, he sent for the white of eggs, which he was fortunate enough to procure in five minutes. Although at this time he had not vomited, he suffered no material harm. Without the prompt use of the albumen, he would almost infallibly have perished §.

Albumen is chiefly useful in the early stage of poisoning with corrosive sublimate, and is particularly called for when vomiting does not take place. But it farther appears to be an excellent demulcent in the advanced stages.

On a previous occasion, mention was made of a few of the facts brought forward by *Professor Taddei* to prove the virtues of the gluten of wheat as an antidote for poisoning with corrosive sublimate, so that nothing more need be said on the subject in the present place. As it is difficult to bring the whole of a fluid containing corrosive sublimate into speedy contact with pulverized gluten, which when put into water becomes agglutinated into a mass, the discoverer of this antidote proposes to give it in the form of emulsion with soft soap. This is made by mixing, partly in a mortar and partly with the hand, five or six parts of fresh gluten with fifty parts of a solution of soft soap. And in order to have a store always at hand, this emulsion, after standing and being frequently stirred for twenty-four hours, is to be evaporated to dryness in shallow vessels, and reduced to powder. The powder may be converted into a frothy emulsion in a few minutes [*].—Taddei made use of this powder with complete success in the case of a man who had swallowed seven grains of corrosive sublimate by mistake for calomel. Violent symptoms followed the taking of the poison; but they were immediately assuaged by the administration of the antidote; and the person soon got quite well [†]. It is probable that wheat-flour will prove an effectual antidote by reason of the gluten it contains. On agitating for a few seconds a solution of twelve grains of corrosive sublimate along with three ounces of a strong emulsion of flour, and immediately filtering,—I find that ammonia and carbonate of potass have little or no effect, that hydriodate of potass occasions a yellow precipitate, and that the acrid, astringent taste of the solution is removed; whence it may be inferred, that the corrosive sublimate is all decomposed, that little mercury remains in solution, and that what does remain is in the form of protochloride of mercury and gluten.

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* Dissert. Inaug. p. 36.

† London Med. Repository, xix. 408.

‡ Trans. of Dublin Coll. of Phys. iii. 310.

§ Journal de Chim. Méd. Mars 1825.

When neither albumen nor gluten is at hand, milk is a convenient antidote of the same kind.

Iron filings would appear to be also a good antidote. *MM. Mylne-Edwards* and *Dumas* have found that when they were administered in the dose of an ounce to animals after twelve or eighteen grains of corrosive sublimate had remained long enough in the stomach for the symptoms to begin, the animals recovered from the effects of the poison, and died only some days afterwards of the effects of tying the gullet, which operation was necessary to prevent them vomiting. The iron obviously acts by reducing the corrosive sublimate to the metallic state [‡].

Meconic acid, the peculiar acid of opium, which will be described under the head of that poison, is also probably a good antidote. *Pettenkoffer* correctly remarks that this acid has a great tendency to form very insoluble salts with the metallic oxides, particularly with the deutoxides, and above all when the acid is previously in union with a base which constitutes a soluble salt [*]. On this account it must be a good antidote. Pettenkoffer adds, that the precipitating action of the meconates is the reason why "the operation of corrosive sublimate on the animal body is almost entirely prevented by opium." Opium, however, cannot be safely used in such quantity as to decompose all the corrosive sublimate in a case of poisoning; for I find that an infusion of thirty-three grains is required to precipitate all which can be thrown down from a solution of five grains of the mercurial salt. I am not aware of any instances on record where poisoning with corrosive sublimate has been prevented or cured by opium given so as to decompose the salt; but a very remarkable case will be related under the head of Compound Poisoning, where the phenomena of its action were masked and altered in a singular manner. There is little doubt that the alkaline meconates must prove valuable antidotes for corrosive sublimate. At present an effectual barrier to their employment is their rarity; but they might now be rendered more accessible, as a great quantity of meconate of lime, which is at present put to no use, is formed in the manufacture of muriate of morphia; and meconate of potass may easily be prepared in sufficient purity from the meconate of lime.

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[*] Recherches sur un Nouvel Antidote, &c. p. 26.

[†] Giornale di Fisica, 1826, vi. 170, and *Buchner's* Repertorium für die Pharmacie, xiii. 229.

[‡] London Medico-Chirurgical Review, v. 612.

As to the old antidotes for poisoning with corrosive sublimate, such as the alkaline carbonates, the alkaline hydrosulphates, cinchona, mercury, charcoal,—*Orfila* has given them all a fair trial, and found them all inefficacious. It would appear, however, from a case related in a late American Journal, that frequent doses of charcoal powder have much effect in soothing the bowels and allaying inflammation after the poison is evacuated [†].

The treatment of mercurial salivation consists in exposure to a cool pure air, nourishing diet, and purgatives, if the intestinal canal is not already irritated. In some of the inflammatory affections it induces, venesection is required; in others it is hurtful. In some complaints induced by mercury, as in iritis, the poison appears to be its own antidote; for nothing checks the inflammation so soon and so certainly as mercurial salivation.

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[*] *Buchner's* Repertorium für die Pharmacie, iv. 51.

[†] *Dr Hort.* American Journal of Med. Science, vi. 540.

Very lately *Dr Finlay* of the United States has proposed to check mercurial salivation by small doses of tartar emetic frequently repeated, so as to act on the skin [*]; and *Mr Daniell* has recommended large doses of the acetate of lead as an effectual antidote for the same purpose [†]. I have tried both of these plans several times with apparent success. In one instance, particularly, where a very severe salivation was threatened by the administration of six grains of calomel in three doses, and where profuse salivation, ulceration of the tongue and swelling of the face actually did commence with violence, the mercurial affection after a few days rapidly receded under the use of large doses of acetate of lead.

A great deal might be said on the treatment of the secondary effects of poisoning with mercury. But a thorough investigation of the subject would lead to such details as would be inconsistent with the other objects of this work.

[*] Edin. Med. and Surg. Journal, xxix. 218.

[†] London Med. Repos. N. S. vi. 368.

CHAPTER XV.

OF POISONING WITH COPPER.

Poisoning with the salts of copper was not long ago a very common accident, in consequence of the metal being much used in the fabrication of vessels for culinary and other domestic purposes, or ignorantly resorted to by confectioners and others to impart a good colour to sweetmeats and preserves. Such accidents have been materially diminished in frequency since the poisonous qualities of the metal, and the circumstances under which it is acted on by articles of food have become known; yet nevertheless they are still frequent enough; and new varieties of adulteration with copper are discovered almost every year. The diffusion among the common people of the knowledge of the properties of copper has also naturally led some persons to have recourse to its preparations for the purpose of self-destruction. And in this point of view, indeed, it holds out several reasons of preference; for one of its compounds, verdigris, is both rapid and sure in its effects, and is so much at hand that no one can have any difficulty in procuring it without suspicion. Poisoning with copper has seldom been caused by the wilful act of another person; for the deep colour of its compounds and their strong disagreeable taste render it a difficult matter to administer them secretly. This, however, though difficult, is not impossible: whatever may be swallowed accidentally, may be also administered secretly by another person. The only instances I have yet met with of a charge of wilful administration, are the case of Anne Inglis tried at Aberdeen in 1795, and the case formerly quoted from a paper of *Chevallier* (p. 78). The woman Inglis was accused of administering the sulphate with intent to poison; but the charge was not proved *. Chevallier's case was an instance of imputation of poisoning.

Section I.—*Of the Chemical History and Tests of the Preparations of Copper.*

Metallic copper has a peculiar red colour, to which it gives its own name. Its specific gravity is nearly 9, its hardness considerable, its tenacity great, its point of fusion about 27° W. or at a full-white heat.

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* Burnett on Criminal Law, 547.

It unites with oxygen in two proportions, forming a yellowish-red protoxide, and a peroxide, which, when dry, is brownish-black,—when hydrated, azure-blue. It unites also with sulphur in two corresponding proportions, forming a gold-yellow proto-sulphuret, the natural copper-pyrites, and a black bisulphuret, which is formed by sulphuretted-hydrogen in all the solutions of this metal. Of the alkalis it unites only with ammonia, that alkali possessing the property of dissolving the peroxide. The acids all unite with the oxide and form salts of a blue or green colour, some of which are soluble, some insoluble. The oxide is frequently mixed with other matters to form various pigments; but in such compounds the union is mechanical, not chemical. Of the substances thus formed and existing in nature and the arts the following only require notice here. 1. *Mineral Green*, and other pigments formed with the hydrated oxide. 2. *Natural Verdigris*, or the carbonate. 3. *Blue Vitriol*, or the sulphate. 4. *Artificial Verdigris*, or the mixed acetates.

1. *Mineral Green.*

The description of this substance and its chemical properties must be introduced with a short account of the tests for the unmixed *Peroxide*. When free of water the peroxide is a brownish-black powder or granular mass, which is usually procured by decomposing the nitrate of copper at a low red heat. It is easily known by the solvent power of nitric acid, the blue colour of the filtered solution, and the beautiful deep violet tint communicated to the solution by an excess of ammonia. The last property is considered by chemists the most satisfactory proof of the presence of oxide of copper in a fluid. It is alone quite infallible, and may be applied to all the soluble and also many insoluble compounds of copper, provided they are not mixed with a large proportion of vegetable or animal fluids. In that case the colour is often greenish.

In the case of the peroxide and the copper poisons generally, the process of reduction, which has been applied with such singular delicacy and precision to arsenical and mercurial poisons, loses all its advantages. The metal remains in the flux, and intimately diffused; so that of its physical qualities the colour only can be estimated, and even that but inaccurately, except in the instance of one compound, verdigris.

The *Hydrated Peroxide of copper*, when newly formed and well prepared, has a fine azure-blue colour; but on exposure to the air, or to a gentle heat, it parts with its water, and becomes the anhydrous peroxide. It is procured by precipitating any of the soluble salts of copper by means of caustic potass. It is at once known by the action of ammonia, which immediately forms with it a deep violet blue solution.

Mineral Green, as already mentioned under the head of arsenic (p. 264,) was originally an arsenical pigment introduced into the art of colour-making by Scheele. But the mineral-green kept in all the shops of this town contains no arsenic, being a hydrate of peroxide of copper intimately mixed with a little lime, which is generally carbonated. This variety of mineral-green probably differs a little as to composition in different manufactories. Some parcels I have found to contain the lime in the state of carbonate; in others the lime was chiefly caustic. It appears not to differ essentially from Verditer.

The best method of determining its nature is to dissolve it in diluted hydrochloric acid, which leaves only a slight cloudiness from accidental impurities; and then to transmit through the filtered solution a stream of sulphuretted-hydrogen gas. The copper on boiling is all thrown down in the form of a black bi-sulphuret, and hydrochlorate of lime remains in solution. The lime is then to be detected by its proper tests, after the solution has been filtered and neutralized (see p. 222.) In general this long process is unnecessary, as the medical jurist may be simply required to say whether the suspected substance contains copper. In that case it is only requisite to subject the substance to the action of ammonia, as if it was anhydrous peroxide.

Verditer, another green pigment, the basis of which is always oxide of copper, does not appear to differ essentially in composition from mineral green. The samples I have examined consist of a large proportion of hydrated oxide of copper, and a small proportion of carbonate of lime.

2. *Natural Verdigris.*

This is a compound of no great importance in a medico-legal point of view. The carbonate of copper exists naturally in two states. In one form it constitutes the rust of copper, or natural verdigris, and is produced as a powdery crust on metallic copper by long exposure to moist air. It is insipid and quite insoluble, so that pure water left in vessels encrusted with it does not become poisonous. It dissolves with effervescence in sulphuric acid, and without effervescence in ammonia, forming the usual violet solution. In another form it exists in the mineral kingdom, constituting the chief part of a very beautiful ore, malachite, and also a considerable proportion of some blue copper ores.

3. *Blue Vitriol.*

Blue vitriol, blue copperas, blue stone, vitriol of copper, as it is variously called in common speech, is the sulphate of copper. In the solid form it constitutes large crystals of a deep blue colour, and an acrid, astringent, metallic taste, efflorescent in dry air, and very soluble in water. Under the action of heat it first parts with its water of crystallization without undergoing the watery effusion; then its sulphuric acid is driven off partly unchanged, partly decomposed; and at last the brown peroxide is left behind in a state of considerable purity. If carbonaceous matter be previously mixed with the sulphate, the oxide is decomposed at a low red heat, so that the process of reduction may be performed in a glass tube. For the reasons formerly stated, this process does not constitute a convenient or characteristic test for the sulphate of copper. The best mode of ascertaining its nature is to dissolve it, and then to apply the tests for the solution.

There are many excellent tests for copper in solution. But the four following are the most delicate and characteristic,—ammonia, sulphuretted-hydrogen, ferro-cyanate of potass, and metallic iron.

1. *Ammonia* causes a pale azure-coloured precipitate, which is redissolved by an excess of the test, forming a deep violet-blue transparent fluid. If the solution is very diluted, there is no previous precipitation; the fluid becomes violet without its

transparency being disturbed. This is a perfectly characteristic test of copper, and one of great delicacy.

2. *Sulphuretted-hydrogen gas* causes a dark brownish-black precipitate, the sulphuret of copper. This test is one of very great delicacy; but it is not alone decisive of the presence of copper, since lead, bismuth, mercury, and silver, are similarly affected by it. A method, however, will be presently described, by which the precise nature of the sulphuret may be determined.

The alkaline hydrosulphates, for example the hydrosulphate of ammonia, answer equally well with sulphuretted-hydrogen. The sulphuretted hydrosulphates, such as the common liver of sulphur, throw down, not a black but a chesnut precipitate.

3. *Ferro-cyanate of potass* causes a fine hair-brown precipitate, the ferro-cyanate of copper. This test is also exceedingly delicate and characteristic.

4. A polished rod or plate of *metallic Iron*, held in a solution of sulphate of copper, soon becomes covered with a red powdery crust, which is the copper in its metallic state; and ere long the solution is changed in colour from blue to greenish yellow. The action is simple; the iron merely displaces the copper in the solution, in which a sulphate of iron is consequently formed. This test is characteristic enough, and even of considerable delicacy. At the same time other substances may cause a reddish encrustation on iron by simply rusting it, so that the test ought not to be relied on alone.

The four preceding reagents taken together are amply sufficient to prove the existence of copper in a solution. Three other tests, however, may be here briefly alluded to.

Caustic potass in a solution not too diluted causes a fine azure-blue precipitate, the hydrated peroxide of copper.

Oxide of arsenic, with the previous addition of a few drops of ammonia, causes a fine apple-green or grass-green precipitate, the arsenite of copper. This test, which is both very delicate and characteristic, has been already fully considered under the head of arsenic.

Galvanic action excited by the method recommended by *Mr. Edmund Davy* for detecting arsenic and corrosive sublimate [p. 257] has the effect of reducing the copper, which attaches itself to the platinum *.

The process by fluid reagents, as hitherto laid down, merely proves the presence of copper; but does not indicate the acid with which the oxide is combined. In order to determine whether it is the sulphuric acid, the fluid must also be tested with nitrate of baryta followed by nitric acid: A heavy white precipitate is thus produced, which the excess of nitric acid does not redissolve.

4. *Artificial Verdigris.*

Artificial Verdigris is a common pigment, which in this country is met with in the form of a light powder of a greenish-blue colour, and peculiar disagreeable smell, approaching that of vinegar. Like blue vitriol it has a strong metallic, astringent taste. The effect of heat is peculiar. Some acetic acid is in the first place distilled over; a portion of the acid, however, remains, which is decomposed and reduces the oxide; and a low red heat is sufficient to make the outer crust of the verdigris distinctly copper-red, when the material is contained in a glass tube.

Artificial verdigris differs in composition according to the mode of manufacture. Foreign verdigris contains the neutral acetate, the subacetate, a little carbonate, oxide, and even metallic copper, along with particles of the fruit and fruit-stalks of the grape. British verdigris consists chiefly of a mixture of the neutral acetate and subacetate, the former of which is soluble, and the latter insoluble in cold water. This difference enables the chemist to separate the two salts from one another. If hot water is used, a part of the subacetate is decomposed, a brown peroxide is consequently formed, while the disengaged acetic acid unites with another portion of the subacetate, rendering it neutral and soluble. The solution has a deep greenish-blue tint.

The best mode of proving the nature of verdigris is to convert it into a solution and treat it with the liquid reagents mentioned under the head of the sulphate of copper. The only difference is, that nitrate of baryta does not cause any precipitation, as there is no sulphuric acid present. The effects of heat already described afford a very good criterion by which the nature of the acid in verdigris may be determined, provided the material is in the solid state.

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* Philosophical Transactions, 1831. cxxi. 158.

It may be right to notice shortly three other salts of copper, the nitrate, the ammoniacal sulphate, and the muriate. The *Nitrate* forms a violet solution, which is acted on by reagents in the same way as the dissolved acetate, but has not any odour of vinegar. The *Ammoniacal sulphate*, or ammoniuret of copper, as it is called in the Pharmacopœias, has been occasionally used in medicine. It forms, when solid, small scaly crystals of an intense violet colour, and strong ammoniacal odour; and when dissolved it retains its peculiar colour even though very much diluted. It is by the formation of the ammoniacal sulphate that the chemist is furnished with the most characteristic test of copper in solution.—The *Muriate* of copper has a lively grass-green colour, and is acted on by reagents in the same way as the solution of verdigris.

Of the corrosion of Copper by articles of food and drink.—To these observations on the chemical history of copper a few remarks must be added relative to the action of various articles of food or drink upon the metal. Unpleasant accidents have often happened from the use of copper vessels in the preparation of food; and it is therefore necessary for the medical jurist to know the circumstances, so far as they have been investigated, under which the poison may be dissolved.

Dr Falconer found, that distilled water kept several weeks on a polished plate of copper, neither injured its lustre, nor acquired any taste, nor became coloured with ammonia[*]; and *Drouard* more recently observed, that distilled water, kept for a month on copper filings, did not contain any of the metal[†]. *Eller* of Berlin, however, remarked, that water, if it contains a considerable quantity of common salt, as four ounces in five pounds, or a twentieth part, will give slight traces of copper after being boiled in a brass pan; and that if the pan be made of copper, a powder is procured by evaporation, which when treated with acetic acid yields so much as 20 grains of acetate of copper [*]. But it is a singular circumstance, also observed by the same experimentalist, that if beef or fish be boiled with the usual allowance of salt, and with the addition also of various vegetable substances, the liquid does not yield any copper. This observation has been confirmed by *Professor Orfila* [†]. Hence copper vessels, although they have often been the source of fatal accidents if carelessly used in the preparation of food, have appeared under careful management to be quite harmless. An excellent practical confirmation of this will be found in *Michaelis'* Commentaries. He states, that in the Orphan Hospital of Halle, the food was in his time prepared in large copper vessels, which were kept remarkably clean, and that out of a population of eight or nine hundred he never heard of any one having suffered from symptoms of poisoning with copper [‡]. Several other saline matters promote the solution of copper in water. Thus *Dr Falconer* found that alum had this effect when aided by heat; and probably nitre and Epsom salt possess the same quality [§]. Their mode of action is not very well known.

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[*] Falconer on the Poison of Copper, p. 23.

[†] Expériences sur l'Empoisonnement par l'oxyde de Cuivre. Diss. Inaug. Paris, 1802. Quoted in *Orfila's* Toxicol. i. 502.

It is a common though erroneous idea, that milk, heated or allowed to stand in a copper vessel, becomes impregnated with the metal. *Eller* has shown, that, on the contrary, if the vessel be well cleaned, milk, tea, coffee, beer, and rain water, kept in a state of ebullition for two hours, do not contract the slightest impurity from copper [||]; and the same remark has been also made by *Dr Falconer* with respect to cabbage, potatoes, turnips, carrots, onions, rice, and barley [¶].

But *Eller* farther remarked, that, if the vessel is not thoroughly clean, then all acid substances dissolve the carbonate that encrusts it, especially if left in it for some time. Nay, it appears that some acid matters, though they do not dissolve clean copper by being merely boiled in it a few minutes, nevertheless, if allowed to cool and stand some time in it, will acquire a sensible impregnation [*]. Dr Falconer also observed, that syrup of lemons, boiled fifteen minutes in copper or brass pans, did not acquire a sensible impregnation; but if it was allowed to cool and remain in the pans for twenty-four hours, the impregnation was perceptible even to the taste, and was discovered by the test of metallic iron [†]. This fact has been farther confirmed by the researches of *Proust* [‡], who states, that, in preparing food or preserves in copper, it is not till the fluid ceases to cover the metal, and is reduced in temperature, that the solution of the metal begins. Inattention to this difference has been the cause of many fatal accidents, of which the following case from *Wildberg's* Practical Manual will serve as a good example. A servant left some sour krout for only a couple of hours in a copper pan which had lost the tinning. Her mistress and a daughter, who took the cabbage to dinner, died of twelve hours' illness; and Wildberg found the cabbage so strongly impregnated with copper, that it was detected by the test of metallic iron [§].

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[*] Sur l'usage prétendu dangereux de la vaisselle de cuivre dans nos cuisines. Histoire de l'Acad. Roy. des Sciences de Berlin, 1756, p. 12.

[†] Toxicol. Gen. i. 502. Orfila's experiments are more satisfactory than those of Eller as to these negative results, because Eller's method of analysis does not appear to be quite free from fallacy.

[‡] *Beck's* Medical Jurisprudence, 460.

[§] Falconer, &c. pp. 48, 98, 110.

[||] Sur l'usage, &c. p. 12.

[¶] Falconer, &c. p. 63.

Wines, at least some wines, have the same power, by reason of the acid they contain. Hence Eller found twenty-one grains of the acetate in five pounds of French white wine, after being boiled in a copper vessel. An epidemic disease, mentioned by *Fabricius*, which broke out in 1592 among the senators of Bern, and a number of their guests who had been invited to a great entertainment, was supposed to have arisen from a poisonous impregnation of this kind. The wine used at the feast had been kept cool in copper vessels immersed in a very cold well. Many of the company were attacked with dysenteric symptoms, and some died [||].

Vinegar also dissolves metallic copper. *Dupuytren* observes that the vinegar sold by hawkers in the streets of Paris generally contains copper from the action of the acetic acid on the stop-cocks of the little vessels in which it is kept [¶]. Others in like manner have found copper in vinegar pickles prepared in copper vessels. Thus *Dr Percival* found a strong impregnation of copper in pickled samphire, of which a young lady ate one morning two breakfast platefuls, and which proved fatal to her in nine days [*]. And *Dr Falconer* once detected so large a quantity in some pickled cucumbers bought at a great London grocer's, that it was deposited on a plate of iron, and imparted its peculiar taste and smell to the pickles [†]. It seems indeed to have been at one time the custom to make a point of adulterating pickles with copper; for in many old cookery-books the cook is told to make her pickles in a copper pan, or to put some halfpence among the pickles to give them a fine green colour [‡].

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[*] Histoire de l'Acad. de Berlin, 1756, p. 16.

[†] Falconer, &c. p. 79.

[‡] Annales de Chimie, lvii. 79, 81.

[§] Practisches Handb. für Physiker, iii. 312, Case 49.

[||] Fabricii Hildani Opera omnia. Genevæ, 1682. De Dysenteria, p. 669.

[¶] *Orfila*, Toxicol. Générale, i. 507.

The action of the vegetable acids, and more particularly of vinegar on copper, depends on the co-operation of the atmospheric air held in solution by the fluid, and in contact with its surface. Without such co-operation the copper cannot be oxidated. This fact, which was determined experimentally by *Proust* [§], will explain the observations of Eller and Falconer,—that it is not dangerous to boil acidulous liquids in copper vessels, while it is very unsafe to keep these fluids cold in the same vessels. In the latter instance the liquid is impregnated with atmospheric air, while in the former the usual aeriform contents are driven off by the heat. I must observe, however, in limitation of Proust's statement, that strong vinegar, such as the pyroligneous acetic acid, will become impregnated to a certain extent if boiled in copper vessels. The action which takes place is the same as that remarked by him in the case of cold vinegar: The copper where it is always covered remains quite bright; but at the edge of the fluid it becomes oxidated, and the oxide is dissolved by the occasional bubbling up of the acid.

In the last place, the property of oxidating and uniting with copper is likewise possessed by fatty matters and oils. According to *Falconer*, fatty substances do not act on metallic copper unless they are rancid [‖]. But *Proust* is probably more correct when he states, that they will act, though fresh, provided they are aided by the co-operation of atmospheric air *. I have found, that, if a plate of copper be thrust into a mass of fresh butter, its surface becomes dark in twenty-four hours, and the butter becomes green wherever it is in contact both with the copper and the air, but not where it covers the metal closely. In fresh hog's lard, however, I have found that the whole lard in contact with the copper becomes blue even at a depth to which the air can scarcely reach. The action of oils is similar. It is even probable that they act when hot; for *Mr Travis* found that hot oil became green when kept for only four or five minutes in a copper vessel †. *Dr Falconer* mentions, that the property of acting on copper is possessed in an eminent degree by volatile oils, and especially by oil of cloves and oil of cinnamon ‡.

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[*] Trans. London College of Physicians, iii. 80.

[†] On the Poison of Copper, 86.

[‡] Ibid. 88; also Paris and Fonblanque's Medical Jurisprudence, ii. 289.

[§] Annales de Chimie, lvii. 80.

[‖] On the Poison of Copper, p. 18.

The general result of the preceding observations is, that there is hardly any article of food or drink which may not become impregnated with copper if kept in copper vessels, as there is hardly any article which does not contain either an acid or some fatty matter; and it farther appears, that the impregnation will scarcely ever take place during the boiling of such articles, but only during the preservation of them in a cold state. It must also be considered, that, independently of these chemical impregnations, articles of food may be mixed mechanically with copper, in consequence of the vessels being allowed, through the carelessness of the cook, to become covered with rust or carbonate, which is subsequently removed by the friction of the solid parts of any article that is boiled in them.

In order to prevent accidental impregnations, copper vessels are usually tinned. The tinning consists of an alloy of tin and lead, which is much less easily attacked than the copper, and the safety of which is farther insured by the circumstance, that the substances endowed with the property of dissolving lead, cannot attack that metal before the whole tin of the alloy is oxidated §. The tinning of copper, however, has been found to be but a partial protection, as the tinning is apt to be worn away without attracting the attention of servants. Hence the use of copper in the fabrication of kitchen utensils is becoming every day more and more limited, especially since the manufacture of cast iron vessels was brought to its present state of perfection in this country.

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* Annales, &c. p. 80.

† Medical Observations and Inquiries, ii. 11.

‡ On the Poison of Copper, 106.

§ *Proust*, Annales de Chimie, lvii. 83.

Many instances might be adduced of the ignorance and carelessness which prevailed, even not far back in the last century, as to the employment of copper vessels for culinary purposes. In addition to the instances already quoted, the following are well deserving of notice. *Gmelin* was consulted by the abbot of a monastery, on account of a violent disease which prevailed throughout the whole brotherhood of monks. The symptoms were obstinate and severe colic, retching and bilious vomiting, costiveness, flatus, burning pain in the pit of the stomach, under the sternum, in the kidneys and extremities, and paralytic weakness in the arms. On inquiring into the cause of this singular combination of symptoms, Gmelin found, that every vessel in the kitchen, the pots and pans, and even the milk pails and butter dishes for storing the butter, were made of copper *. —In 1781 an establishment of Jacobin monks at Paris were all violently affected from a similar error. The cook on a Friday and the subsequent Saturday, after boiling fish for the dinner of the monks in a copper pan, and, drawing off the water, poured vinegar over the fish, and left it thus in the pan for a considerable time. On the evening of Friday several of them were taken severely ill with headach, acute pain in the stomach and bowels, præcordial anxiety, purging, great feebleness and cramps in the legs. The rest of them, to the number of twenty-one in all, were similarly attacked next day; and the symptoms continued in most of them for five or six days †.

A singular variety of adulteration with copper has lately been brought into public notice on the continent,—namely, the impregnation of bread with the sulphate of copper, which is used in small quantity for promoting the fermentation of the dough. This practice was first detected in some of the towns of Flanders; but has also been since found to prevail in France ‡. Some chemists of reputation have indeed doubted altogether the existence of the practice; and *M. Barruel* in particular, who was consulted on the subject by the Prefecture of Paris, has publicly declared his disbelief, because he remarked that, instead of favouring the panary fermentation, a very small proportion of sulphate of copper actually impeded it, and besides gave the bread a greenish colour of such depth that no customer would take it for a wholesome article *. Subsequent inquiries, however, have shown that Barruel must have allowed himself to be misled, probably by using too much of the sulphate of copper. For the bakers of St Omer have admitted that they practice this adulteration for the sake of saving their yeast, the proportion required being an ounce of the salt in two pints of water for every hundred weight [*quintal*] of dough, or about an 1800th part †. And it appears from an interesting set of experiments by *M. Meylink*, a chemist of Deventer, that, contrary to the statements of Barruel, sulphate of copper not only possesses the property of promoting the panary fermentation, but likewise constitutes in several important respects a source of adulteration, which ought to be prohibited and strictly looked after. He found that when he added to half a Flemish pound of dough from one grain to eight grains of sulphate of copper, fermentation took place more quickly than in the same dough without such addition, and nearly in proportion to the quantity of the salt used;—that the adulterated loaves when taken out of the oven were much better raised, and the loaf with only one grain of the salt likewise much whiter, than those which were not adulterated;—that a slight increase, however, in the proportion rendered the loaf greenish, and gave it a peculiar taste;—but especially that the employment of the salt of copper even in the small proportion of one grain had the singular effect of bringing about the complete fermentation of the dough with considerably less loss of weight than occurs in the common process of baking, the loss in the sound and in the adulterated loaves being in the proportion of 116 to 100 ‡. It certainly seems fully proved, then, that the adulteration of bread with sulphate of copper is an important fraud in more ways than one. Some doubt may be entertained whether any injury can result to the human body from even the habitual use of so small a quantity

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* Geschichte der Mineralischen Gifte, p. 77.

† Lond. Med. Journal, ii. 411, from Journ. de Méd.

‡ Archives Gén. de Méd. xix. 471.

* Annales d'Hygiène Publ. et de Méd. Légale, iii. 342.

† Archives Gén. de Méd. xxi. 145.

‡ *Buchner's* Repertorium für die Pharmacie, xxxiii. 236.

as is employed by the bakers; and, at all events, we may be satisfied that if any bad effects do result, this can only happen from the continual use of the adulterated bread for a great length of time. But there can be no doubt that the practice is a serious fraud on the public, by enabling the baker to make his loaves of the standard weight with a less allowance of nutritive material.

Another important adulteration also indicated by foreign chemists is that of syrup made with the coarsest kinds of sugar, and decolorized by means of sulphate of copper. The colour is removed by adding a solution of the sulphate to the syrup boiling hot, and decomposing the salt by lime; but a portion of the copper salt is often left behind, and in consequence serious accidents have arisen from such syrups being used in making various medicinal preparations [*].

Of the detection of Copper in vegetable and animal mixtures. The chemical action of blue vitriol and verdigris with the common articles of food and drink, or the contents of the alimentary canal, and the differences produced by these substances on the operation of reagents, have not been so satisfactorily examined as could be wished.

Some substances, such as albumen, milk, tea, and coffee, decompose the solutions of copper; while others, such as red wine, bile, matter vomited from the human stomach, and the coats of the stomach, although they do not decompose the salts of copper, or at least but partially, will, nevertheless, alter materially the action of the tests in the process of analysis described above. It is quite unnecessary to enter into a detailed proof of this statement, the accuracy of which has been established by *Orfila* [†].

When vegetable and animal fluids, therefore, are suspected to contain copper, a different method of analysis must be followed. The process which has appeared to me the most convenient, is analogous to that for the detection of arsenic in like circumstances. But sometimes two examinations are required, one for the soluble, the other for the insoluble matter.

In order to throw as much of the copper as possible into the first branch of the analysis, the substance for examination, after being boiled, is to be treated with diluted acetic acid. The acid dissolves out the copper from the organic principles with which it has been united in the form of insoluble compounds.

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[*] *Pignant* in Journ. de Chim. Méd. viii. 339.

[†] Toxicologie Générale, i. 510.

[It may be well to explain shortly the operation of the acetic acid in this preliminary step; and as examples of its operation on compounds of copper with organic principles, tea, milk, and albumen may be taken.

When sulphate of copper is added to an infusion of tea, a dark precipitate is formed,—consisting of oxide of copper and vegetable matter, without sulphuric acid. Acetic acid now added dissolves out the oxide of copper almost entirely; for if the insoluble matter which then remains be collected and thoroughly washed, it will be found to contain only the merest trace of copper by the second branch of the present process of analysis.

Milk is similarly circumstanced with tea. When mixed with a solution of sulphate of copper, the caseïn falls down with the oxide, in the form of a bluish-white, curdy precipitate; from which (as I have repeatedly ascertained) acetic acid dissolves out the whole oxide, leaving the curdy caseïn undissolved but whitened.

With albumen the action of the acetic acid is a little different. Albumen dropped into a solution of the copper-salt, causes a dense bluish-white coagulum, which dries into deep bluish-green, vitreous masses, consisting of albumen and oxide of copper. If the precipitate has not been exposed to a temperature about 212°, it is entirely redissolved on the addition of a little acetic acid. But if the albuminated oxide has been either boiled in the water or dried in the vapour-bath, it is acted on in the same way as the precipitate formed by solutions of copper in milk. The latter action is very distinctly shown by immersing little masses of the dry albuminate in diluted acetic acid. In a few hours the blue colour is entirely removed, nothing being left but coagulated albumen.]

The suspected mixture thus prepared by the addition of acetic acid is to be subjected to filtration, and any matter left on the filter is to be washed, collected, and dried, the washings being of course added to the fluid which first passed through. The process here divides itself into two; for the oxide of copper may be left on the filter in the form of an insoluble salt, or it may have passed through in solution. But it may be observed in passing, that very few of the salts of copper are insoluble in diluted acetic acid, so that if copper is present at all in a suspected mixture, there are many chances in favour of its being found by the first branch of the analysis.

First branch.—The solution is to be examined first, both because it is the more likely quarter in which to find the copper, and because the analysis is more easy than that of the solid matter. The solution then is to be treated in the usual way with a stream of sulphuretted-hydrogen, and immediately boiled to expel the excess of gas. If a brownish-black or even pale-brown precipitate is then thrown down, there is a presumption in favour of the existence of copper: If there is no precipitate or brown coloration, there is no copper in the fluid. In order to ascertain precisely the nature of the precipitate, which is some metallic sulphuret, the superincumbent fluid, after ebullition and subsidence of the precipitate, is to be cautiously withdrawn, and its place supplied with water; and when the washing has been several times repeated in the same manner, the precipitate is to be transferred into a watch-glass, or, still better, into a white porcelain cup, and dried. It is next to be collected, and incinerated in a glass tube, to destroy any adhering vegetable or animal matter. The last step in this branch of the process is to convert the sulphuret into the sulphate by the action of a few drops of nitric acid, aided by a gentle heat,—and then to add an excess of ammonia, either without or with previous filtration, according to the degree of muddiness in the nitrous solution. If copper is present the usual deep violet-blue tint will be struck.

Second branch.—If copper is not detected in the filtered part of the suspected matter, it will be necessary to examine also what remained on the filter. This proceeding, which constitutes the second branch of the analysis, will be seldom required in ordinary medico-legal researches, being rendered necessary only by the possibility of the oxide of copper having, either originally or after mixture with the suspected matter, assumed the form of an inorganic salt, insoluble in water or acetic acid.

The matter on the filter is first to be well dried, and then heated to redness in a crucible till it be completely charred. The copper which is thus reduced to the metallic state, is next to be treated with nitric acid, diluted with its weight of water, and aided in its action by gentle heat. A solution is then procured, which is to be removed by filtration and tested with ammonia, and the other liquid tests.

The process for detecting copper, as now described, is one of great delicacy, and the first part sufficiently simple and easy. I have detected by means of it, and without having had recourse to the second branch, a tenth of a grain of sulphate of copper, or more properly speaking, a 35th of a grain of oxide of copper in five ounces, that is in 84000 times its weight of tea made with cream and sugar. The sulphuretted-hydrogen caused a pale-brown muddiness, which under exposure to the air gave place to a darker brown precipitate; and when this was heated to redness, and acted on by nitric acid, ammonia produced a deep blue colour in the solution.

This process possesses several advantages over the one proposed by Orfila; of which, however, it is only a slight modification.—The preliminary addition of the acetic acid is an important improvement, because in many cases, indeed in all the common medico-legal cases, such as when the search is to be made in the contents of the stomach, vomited matters, or articles of food and drink, the second branch of the analysis,—a troublesome one for the inexperienced to conduct without error,—is rendered unnecessary.—The incineration of the sulphuret before treating it with nitric acid is an essential precaution which Professor Orfila has omitted. For if the poison is only in moderate or small proportion, the sulphuret is combined with so much animal and vegetable matter, that the final test of ammonia does not act characteristically, without the previous ignition of the sulphuret, but produces a green instead of a blue tint. This has happened to me often, first in analyzing a liqueur in which the presence of copper was suspected, and frequently in express experiments with tea containing sulphate of copper. In the last edition of his Médecine Légale Orfila says he considers the precaution here adverted to unnecessary, as he has never found occasion for it *. In reply I have only to quote my own experience to the contrary.

Of course neither Orfila's process nor that recommended in the present work will tell with what acid the oxide of copper

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* Traité de Médecine Légale, 3ème edition 1832, iii. 194.

is in combination. This defect, however, is of small consequence.

Two other processes for detecting copper in compound mixtures may here be mentioned.—*MM. Orfila* and *Barruel* in cases of suspected adulteration of bread with copper, charred and incinerated the whole bread at once, and then acted on the residue with nitric acid,—in short, followed the same method of analysis as that which constitutes the second branch of the process described above. There is no objection to this method, except the difficulty which an unpractised chemist will have in managing the incineration of the mixture: for it appears from the researches of the authors that perfect incineration is indispensable for success where the proportion of copper is very small. —*MM. Henry*, *Deyeux*, and *Boutron-Charlard*, who were deputed by the Parisian Academy of Medicine to investigate the subject of the adulteration of bread with zinc and copper, and to devise a process for the detection of these metals, suggest the following mode of analysis. Heat the suspected bread with rather less than its weight of nitric acid, till it be reduced to a small bulk, adding more nitric acid as it evaporates. Dissolve the product in nitric acid, filter, and add ammonia to throw down iron and phosphates. Filter, acidulate with nitric acid, and evaporate to a small volume. Ammonia and ferrocyanate of potass will now act characteristically, if copper be present; and the hydrosulphate of ammonia, potass, and ammonia, if zinc be present, will produce the effects which will presently be mentioned under the head of that metal *.

A singular discovery has been not long ago announced which some have thought will subject every process of analysis in cases of suspected poisoning with copper to fallacy. A few years ago *Meissner* pointed out the existence of a trace of copper in some vegetable substances †; and more recently a French chemist, *M. Sarzeau*, has stated that a minute quantity of this metal may be detected not only in all vegetable substances, but likewise in the blood and other fluids and solids of the animal body. Among vegetable substances he examined with great care cinchona-bark, madder, coffee, wheat and flour; and he succeeded in separating metallic copper from them all *.

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* Journal de Pharmacie, xv. 58.

† Schweigger's Journal der Chemie, xvi. 340, 436, or Annales de Chim. et de Phys. iv. 106.

The accuracy of these researches has been called in question. By some chemists the discoveries of *Meissner* and *Sarzeau* have been confirmed so far as they relate to vegetable substances. By others again the same results have not been obtained, more especially in the case of animal solids and fluids. In the course of an inquiry I undertook a few years ago relative to the question whether poisons pass into the blood I failed to detect copper in the blood, muscles, or spinal marrow of animals, although the method of analysis must have enabled me to discover extremely minute quantities of that metal. And more recently *M. Chevreul* was unable to detect the slightest trace of copper in beef, veal, or mutton; nor was he more successful in the case of wheat, provided care was taken to keep the sample clean †. These discrepant results appear to be in a great measure reconciled by an extensive inquiry into the subject by *M. Boutigny;* who found that wheat, wine, cyder, and some other substances of a vegetable nature do frequently present minute traces of copper, but only when copper is contained in the manure used in raising the grain, grapes, apples, and the like; that manure from the streets of great towns always contains copper, and introduces it into vegetable articles grown where such manure is used; and that the occasional presence of the same metal in animal substances may be traced either to copper vessels having been employed in preparing or preserving them, or to the animals producing them having been fed on vegetables presenting from the cause mentioned above a faint cupreous impregnation ‡.

These interesting facts, however, can scarcely be considered as a serious objection to the conclusiveness of an ordinary medico-legal analysis; for the proportion of copper contained in the substances examined by M. Sarzeau and others, never exceeded a 120,000th part, and sometimes did not amount to more than a 1,500,000th part,—proportions so minute that they could scarcely interfere with the results of a medico-legal analysis.

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* Journal de Pharmacie, xvi. 505.

† Journal de Chimie Med. viii. 442, 573.

‡ Ibidem, ix. 147.

SECTION II.—*Of the Action of Copper, and the Symptoms it excites in Man.*

The symptoms caused by copper have at least two varieties in their character. One class arises from its local action on the alimentary canal; the other from its operation on distant organs.

This double influence is proved by the experiments of Drouard on animals, published in his Inaugural Dissertation at Paris in 1802; and by those of Orfila in his Toxicology.

When *Drouard* gave twelve grains of verdigris to a strong dog fasting, he observed that it caused aversion to food, efforts to vomit, diarrhœa, listlessness, and death in twenty-two hours; and that the stomach was but little inflamed. When two grains dissolved in water were injected into the jugular vein of another dog, it caused vomiting and discharge of fæces in seven minutes, then rattling in the throat, and death in half an hour; and there was no particular morbid appearance in the body. Half a grain killed another in four days; and in addition to the preceding symptoms, there was palsy of the hind-legs for a day before death. Six grains of the sulphate introduced into the stomach killed a dog in half an hour, without producing any appearance of inflammation *.

These experiments prove that it is not by causing local irritation that this poison proves fatal. But its mode of action is more distinctly shown in the later and more accurate experiments of *Orfila*. He found that twelve or fifteen grains of the neutral acetate generally killed dogs within an hour; and that besides the usual symptoms of irritation in the stomach, they often had insensibility, almost always convulsions, and immediately before death rigidity, or even absolute tetanus. He likewise remarked violent convulsions and insensibility when a grain of this salt was injected into the veins; and death was then seldom delayed beyond ten minutes. In no case was there any particular morbid appearance, except loss of contractility in the voluntary muscles †.

Allied to these results, are those obtained by my colleague, *Dr Duncan*, when the sulphate was applied to a wound. The animal died in twenty-two hours, and the body was everywhere in a healthy state. But it is singular that, according to the experiments of *M. Smith*, repeated by Orfila, the acetate has no such effects when applied to wounds. One or two drachms applied to a wound in the thigh of a dog caused only local inflammation, and no constitutional symptoms[*].

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* Orfila, Toxic. Gén. i. 511.

† Ibidem, i. 513.

It follows from the researches now detailed, that the salts of copper act in whatever way they are introduced into the system, and the more energetically, the more directly they enter the blood.

Copper has been sought for, with variable success, in the blood of animals poisoned with its salts. Drouard was unable to detect it in the blood. But this need not excite surprise, because the same physiologist could not detect it, even when he had injected it into a vein.—More lately, *Lebküchner*, who published a thesis at Tübingen in 1819, on the permeability of the living membranes, succeeded in discovering it. He introduced four grains of the ammoniacal sulphate into the bronchial tubes of a cat, and five minutes afterwards, when the animal was under the action of the poison, he drew some blood from the carotid artery and jugular vein; and he detected copper in the serum of the former, but not in the latter, by sulphuretted-hydrogen and hydrosulphate of ammonia[†].—Still more recently *Dr Wibmer* of Munich also succeeded in discovering it. In a dog which had taken from four to twenty grains daily of the neutral acetate for several weeks, he found the metal in the substance of the liver, but not anywhere else. In the charcoaly matter left by incinerating the liver, nitric acid formed a solution, which when neutralized gave the characteristic action of the salts of copper with sulphuretted-hydrogen, ferrocyanate of potass, and ammonia[‡]. These results, if they shall be confirmed by future inquiries, are peculiarly important, as they tend to prove that poisons introduced into the body accumulate in particular organs only. A parallel set of facts announced by the same author will be mentioned in the chapter on Lead. The observations of Sarzeau on the presence of traces of copper in the blood and soft solids of the healthy body, even if confirmed, will not necessarily invalidate Wibmer's researches; since Wibmer detected it in one organ only, but there characteristically.

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[*] Toxicol. Générale, i. 515.

[†] Utrum per viventium adhuc anim. membr. et arter. pariet. mat. ponderab. permeare queant, 13.

[‡] Ueber die Wirkung des Kupfers auf den thierischen Organismus, in *Buchner's* Repertorium für die Pharmacie, xxxii. 337, 1829.

Dr Duncan's experiment on its effect when applied to a wound, shows that it may prove fatal when applied externally. Yet in small quantities, the sulphate is daily used with safety for dressing ulcers.

As to the preparations of copper which are poisonous, it is pretty certain that, like all other metals, it is not deleterious unless oxidated, and that its soluble salts are by far the most energetic. *Portal*, indeed, has related the case of a woman who, while taking from half a grain to four grains of copper filings daily, was seized with symptoms of poisoning *. But it is probable the filings were oxidated; for *Drouard* gave an ounce to dogs without injuring them at all †. Hence many persons have swallowed copper coins and retained them for weeks without having any symptoms of poisoning with copper.

The sulphuret is equally innocuous with the metal if pure; but it appears probable that it becomes oxidated by long exposure to the air, and passes into the state of sulphate. *Orfila* found that an ounce of recently prepared sulphuret had no effect on a dog; but half an ounce of a parcel which had been long kept caused vomiting, and yielded a little sulphate to water ‡. The power of the oxides has not been ascertained. They are certainly poisonous; but they are probably not very active, on account of their insolubility. The hydrated deutoxide is probably more active. From some experiments made at the hospital of St Louis in Paris, it appears that twelve grains will cause nausea, pain in the stomach and bowels, vomiting and diarrhœa §. But it is chiefly in the soluble salts that we are to look for the full developement of the action of this poison. A very small quantity of the sulphate will prove fatal; for, as already noticed, Drouard found that six grains killed a dog in half an hour.

The symptoms caused by the soluble salts of copper in man are, in a general point of view, the same with those caused by arsenic and corrosive sublimate. But there are likewise some peculiarities. According to the cases related by Orfila in his Toxicology, the first symptom is violent headach, then vomiting and cutting pains in the bowels, and afterwards cramps in the legs and pains in the thighs. Sometimes throughout the whole course of the symptoms there is a peculiar coppery taste in the mouth, and a singular aversion to the smell of copper. *Drouard* notices this in his thesis, and says, that, having himself been once poisoned with verdigris, the smell of copper used for a long time after to excite nausea[*]. Another symptom, which occasionally occurs in this kind of poisoning, and never, so far as I know, in poisoning with arsenic or corrosive sublimate, is jaundice. It likewise appears that, when the case ends fatally, convulsions and insensibility very generally precede death.

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* Observations sur les effets des vapeurs méphitiques, 437.

† *Orfila*, Toxicol. Générale, i. 500.

‡ Arch. Gén. de Médecine, xix. 329.

§ *Corvisart's* Journal de Médecine, xviii. 54.

The following case communicated to Professor Orfila by one of his friends will convey a good idea of the symptoms when they do not prove fatal. A jeweller's workman swallowed intentionally half an ounce of verdigris, suspended in water. In fifteen minutes he was attacked with colic pains and profuse vomiting and purging. When seen by the physician eight hours afterwards there was not much vomiting, but frequent eructation of a matter containing verdigris, some salivation, a small pulse, and blueness about the eyes. In sixteen hours jaundice began to appear. In the course of the night he was a good deal relieved from the colic pains by three alvine discharges; and next morning he had ceased to vomit, and the pain had disappeared. But he complained of a taste of copper in his mouth, and the jaundice had increased. From this time he recovered rapidly, and on the fourth day his convalescence was confirmed[†].

When the poisoning ends fatally, convulsions, palsy, and insensibility, the signs in short of some injury done to the brain, are very generally present. This is illustrated by a good example in *Pyl's* Essays and Observations. It was the case of a confectioner's daughter, who took two ounces of verdigris, and died on the third day under incessant vomiting and diarrhœa, attended towards the close with convulsions, and then with palsy of the limbs. This case, however, is chiefly valuable for the dissection, which will be noticed presently[‡]. But two cases of the same description are related in greater detail by *Wildberg* in his Practical Manual, which clearly show the action of this poison on the brain. They are the cases formerly alluded to of a lady and her daughter who were poisoned by sour-krout kept in a copper pan. Soon after dinner they were attacked first with pain in the stomach, then with nausea and anxiety, and next with eructation and vomiting of a green, bitter, sour, astringent matter. The pain afterwards shot downwards throughout the belly, and was then followed by diarrhœa; afterwards by convulsions, at first transient, then continued; and finally by insensibility. The daughter died in twelve hours, the mother an hour later [*]. In these three cases, although there was not any jaundice noticed during life, the skin was very yellow after death.—In some instances it would appear that narcotic symptoms form the commencement and irritant symptoms the termination of the poisoning. This unusual relation occurs in a case of recovery related by *M. Julia-Fontenelle*, and also, though less remarkably, in a fatal case mentioned by *Wibmer*. The subject of the former was a man who intentionally took a solution of copper in vinegar, prepared by keeping several sous-pieces seven days in that fluid. In three hours he was found in a state of insensibility, with the jaws locked, the muscles rigid and frequently convulsed, the breathing interrupted, and the pulse small and slow. In half an hour he was so far roused that he could tell what he had done; and soon after taking white of eggs the convulsions ceased: but next day the belly was hard and tender, and the repeated application of leeches was required to subdue the abdominal irritation that ensued [†]. In the fatal case by *Wibmer*, that of a girl of 18, who was poisoned by a dish of beans having been cooked in a copper vessel, sickness, pain of the belly and vomiting speedily arose, but were soon followed by convulsions and loss of consciousness. Next day there was little pain but extraordinary paralytic weakness of the arms and legs; the abdomen afterwards became distended and painful; and death took place in seventy-eight hours [‡].—A case where convulsions were produced by two drachms of blue vitriol is mentioned by *Dr Percival* [§].

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[*] *Corvisart's* Journal de Médecine, xviii. 56.

[†] Toxicol. Générale, i. 519.

[‡] Aufsätze und Beobacht. aus der gericht. Arneiwiss. viii. 85.

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[*] Practisches Handbuch für Physiker, iii. 308.

[†] Journ. de Chimie Médicale, v. 413.

[‡] Die Wirkung der Arzneimittel und Gifte, ii. 258.

[§] Trans. London Coll. Phys. iii. 88.

Besides these effects when introduced in considerable doses and in the form of soluble salts, copper is said to produce other disorders when applied to the body for a long time in minute quantities and in its metallic or oxidized state. Among those artisans who work much with copper various affections are thought to be gradually engendered by merely handling the metal. *Patissier* in his treatise on the diseases of artisans says, that copper-workers have a peculiar appearance which distinguishes them from other tradesmen,—that they have a greenish complexion,—that the same colour tinges their eyes, tongue, and hair, their excretions and even their clothes through the medium of the perspiration,—that they are spare, short in stature, bent, their offspring ricketty, and they themselves old and even decrepit at their fortieth or fiftieth year [*]. *Mérat* also asserts that they are liable to the painter's colic, that peculiar disease soon to be noticed as a common effect of the long continued application of lead [†].

But these notions must be received with some limitation. At least the alleged effects on copper-workers are by no means invariable. For copper-workers now-a-days in this country and elsewhere are by no means the unhealthy persons Patissier represents them to be. As to colica pictonum, it is very rare among them; and possibly the cases noticed by Mérat might have been produced by the secret introduction of lead into the body, if indeed they were not cases of common colic.

SECTION III.—*Of the Morbid Appearances caused by Copper.*

The appearances found in the body after death by poisoning with copper are chiefly the signs of inflammation.

Where death takes place very rapidly, however, it is probable that no diseased appearance whatever will be perceptible. At least this was the case in the animals experimented on by Drouard and Orfila; and little doubt can therefore be entertained that the result would be the same with man also in similar circumstances.

When death ensues more slowly, as in the only fatal cases yet recorded of its action on man, the marks of inflammation coincide with the signs of irritation during life. The best account I have seen of the morbid appearances under such circumstances is in the cases related by *Pyl*, by *Wildberg*, and by *Wibmer*.

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[*] Traité des Maladies des Artizans, p. 78.

[†] Traité de la Colique Métallique, p. 103.

In Pyl's case the whole skin was yellow. The intestines, particularly the lesser intestines, were of an unusual green colour, inflamed, and here and there gangrenous. The stomach was also green; its inner coat was excessively inflamed; and near the pylorus there was a spot as big as a crown, where the villous coat was thick, hard, and covered with firmly adhering verdigris. The lungs are likewise said to have been inflamed. The blood was firmly coagulated.

In the cases related by Wildberg, which are very like each other, the skin on various parts, and particularly on the face, was yellow; but on the depending parts it was livid. The outer coat of the stomach and intestines was here and there inflamed; and the inner coat of the former was very much inflamed, and even gangrenous[*] near the pylorus and cardia. The duodenum and jejunum, and likewise the gullet, were in a similar state. The blood in the heart and great vessels was black and fluid.

In the case of the girl referred to by *Wibmer*, the skin was ochre-yellow, the stomach green, much inflamed, especially near the pylorus, the gullet and intestines also inflamed, the diaphragm red, the brain healthy, the lungs and heart "gorged with thick blood."

The intestines have been found perforated by ulceration, and their contents thrown out into the sac of the peritonæum. *Portal* has related one case where the small intestines were perforated, and several where the perforation was in the rectum, which portion of the intestines, as well as the duodenum, jejunum, and ileum, was also extensively ulcerated[†].

The existence of verdigris in the form of powder lining the inside of the stomach after incessant vomiting for three days, is of course an important circumstance in the inspection of the body. But too much reliance ought not to be placed on mere bluish or greenish colouring of the membranes. For *Orfila*[‡] and *Guersent* [*] have both observed, that the inside of the stomach as well as its contents may acquire these tints in a very remarkable degree in consequence of natural disease.

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[*] Gangrene could not have taken place in thirteen hours. The appearance must have been black extravasation, which has often been mistaken for gangrene. See page 314.

[†] *Portal* sur les effets des vapeurs méphitiques, 436, 439.

[‡] *Orfila*, Tox. Gén. i. 530.

Section IV.—*Of the Treatment of Poisoning with Copper.*

The treatment of poisoning with the salts of copper has been examined in relation to the antidotes by M. Drouard, M. Marcelin-Duval, Professor Orfila, and M. Postel.

The Alkaline Sulphurets were at one time thought to be antidotes for the poisons of copper, but without any reason. *Drouard* found that fifteen grains of verdigris killed a dog in thirty hours, notwithstanding the free use of the liver of sulphur [†].

More recently *M. Marcelin-Duval* was led from his experiments to infer that sugar was an antidote [‡], and in the first editions of his Toxicology *Professor Orfila* agreed with him, and related some experiments of his own, which, along with those of Duval, seemed to place the fact beyond all doubt. Later and more careful experiments however satisfied Orfila, as he announced in the last edition of his Toxicology, that it only acts as an emollient after the poison has been removed from the stomach, and that it has no effect at all if the poison is retained by a ligature on the gullet [§]. Sugar being thus rejected as well as the sulphurets, he was led to try the effects of albumen; and his experiments have induced him to recommend that substance as an antidote in preference to every thing else. He found that the white of six eggs completely neutralized the activity of between 25 and 36 grains of verdigris; so that even when the mixture was retained in the stomach by a ligature on the gullet no effect ensued which could be ascribed to the poison. He infers that white of egg is the best antidote for poisoning with copper [‖]. He likewise found the ferrocyanate of potass not inferior [¶].

Since the publication of these inquiries the subject has been again examined by *M. Postel*, who reverts to the original proposition of Duval, that sugar is really a good antidote; and he founds this conclusion partly on direct comparative experiments, showing that it is at least equally effectual with white of egg, and partly on the singular fact ascertained by him, that sugar, which was believed to decompose the salts of copper only at the temperature of 212°, does actually accomplish this decomposition at the temperature of the human body, and throws down the copper in the form of oxide [*].

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[*] Dict. des Sciences Médicales, vii. 564.

[†] *Orfila*, Toxic. Gén. i. 534.

[‡] Ibidem, i. 535. [§] Ibidem. 539. [‖] Ibidem, 540. [¶] Ibidem, 541.

According to the experiments of *MM. Mylne-Edwards* and *Dumas*, metallic iron is likewise a good antidote: They found that when fifteen, twenty, and even fifty grains of sulphate of copper, acetate of copper, or verdigris, were given to animals, and an ounce of iron filings administered either immediately before, or immediately afterwards,—the gullet being tied to prevent the discharge of the poison,— death did not ensue for five, six, or even eight days, and consequently proceeded from the operation on the gullet; and that in one experiment, on the ligature being removed from the gullet, the opening healed up, and complete recovery took place [†].

Before quitting the subject of the treatment, it is necessary to caution the practitioner particularly against the employment of a substance ignorantly used for this, in common with many other, species of poisoning,—vinegar. On account of its solvent power over the insoluble compounds formed by the salts of copper with animal and vegetable matters, it must be injurious rather than useful.

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[*] Journal de Pharmacie, xviii. 570.

[†] London Medico-Chirurgical Review, v. 611.

CHAPTER XVI.

OF POISONING WITH ANTIMONY.

The Fourth genus of the Metallic Irritants includes the preparations of Antimony. Poisoning with antimonial preparations is not very common. They are employed extensively in medicine, however, and consequently accidents have sometimes occurred with them. One of them is also often foolishly used, in the way of amusement, to cause sickness and purging, and likewise to detect servants who are suspected of making free with their mistress's tea-box or whisky-bottle; and in both of these ways alarming effects have sometimes been produced. In large doses some of the antimonial compounds may cause death; and one of them, the Butter of Antimony, now very little or never put to use in this country, is a violent corrosive.

Section I.—*Of the Chemical History and Tests for the preparations of Antimony.*

Metallic antimony has a bluish-white colour, not liable to tarnish. Its specific gravity is 6.7 It is easily fused, but is not very volatile. In certain circumstances, however, it easily undergoes a spurious sublimation, by being carried along with the gases disengaged while it is in the act of being reduced. This curious phenomenon will be exemplified presently.

A great number of preparations of antimony were at one time to be found in the shop of the apothecary; but they are now reduced to a few. Those which require notice here are the prepared sulphuret, the precipitated sulphuret, and tartar emetic.

The *Prepared Sulphuret* is sold in brownish-black cakes or powder; it dissolves in diluted muriatic acid with the aid of heat, sulphuretted-hydrogen being evolved. The best mode of showing the presence of antimony in it is the method of *Dr Turner*, who proposes to place a little in a horizontal tube, to transmit hydrogen gas through the tube by means of the apparatus represented in Figure 9; and when all the air of the apparatus is expelled, to apply heat to the sulphuret with a spirit-lamp. Sulphuretted-hydrogen is evolved, and metallic antimony is left if the current of hydrogen be gentle, or it is sublimed if the current be rapid [*]. I have seldom been able to procure metallic globules with a small tube by heating the sulphuret with potass, according to the process recommended by Orfila. His process rarely succeeds on the small scale.

The *Precipitated Sulphuret* is always in the form of a dirty scarlet or reddish-brown powder. It yields metallic antimony by the process of reduction with hydrogen; but not easily on a small scale with potass.

Tartar Emetic.

In its solid state Tartar emetic forms regular tetraedral crystals of a yellowish white colour, efflorescent, and of an acid and slightly metallic taste. As commonly seen in the shops it is in the form of a white, or pale yellowish white powder.

When heated it decrepitates and then chars; and if the heat be increased the oxide of antimony is reduced by the carbonaceous matter, and little globules like those of quicksilver in point of colour are found in the mass. The best way of reducing tartar emetic is to char it in a porcelain vessel or watch-glass, and then to increase the heat till the charred mass takes fire. Or the charred mass may be introduced into a tube and heated strongly with the blowpipe, after which globules of antimony will be found lining the bottom of the glass where the material has been. None of it is ever sublimed. It is not easy to procure distinct globules by heating tartar emetic at once in a small tube.

According to *Dr Duncan*, Tartar Emetic is soluble in three parts of boiling and fifteen of temperate water. The solution presents with reagents various peculiar appearances, which have been examined with great care by *Dr Turner* [*].

1. *Caustic potass* precipitates it white, but only if the solution is tolerably concentrated. The first portions of the test have no effect, as the tartrate contains an excess of acid which must be neutralized. The precipitate thrown down, which is the oxide of antimony, is redissolved by an excess of potass.

2. *Lime-water* precipitates the solution white, and with somewhat greater delicacy than caustic potass. It does not act, however, when the solution contains only half a grain to an ounce.

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[*] On the Detection of Antimony in mixed fluids. Ed. Med. and Surg. Journ. xxviii. 71.

3. *Subcarbonate of potass* acts with still greater delicacy,—throwing also down a white precipitate. It does not act if the solution contains only a quarter of a grain to an ounce.

4. *Muriatic and sulphuric acids* throw down a white precipitate, and take it up again when added in excess. The sulphuric acid requires to be added in large excess to accomplish the solution of the precipitate. Their delicacy is equal to that of carbonate of potass.

5. The *infusion of gall-nuts* when fresh and strong causes a dirty, yellowish-white precipitate; but it is a very ineligible test, as it will not act on a solution which contains much less than two grains per ounce.

6. By far the best reagent is *sulphuretted-hydrogen*. In a solution containing only an eighth part of a grain per ounce, it strikes an orange-red colour, which, when the excess of gas is expelled by heat, becomes an orange-red precipitate; and if the proportion of salt is greater, the precipitate is thrown down at once.—The colour of the precipitate is so peculiar as to distinguish it from every other sulphuret; but if any doubt regarding its nature should occur, it may be known at once by the process of reduction with hydrogen gas.

Tartar Emetic, like the soluble salts of mercury and copper, is decomposed by various organic principles. All vegetable substances that contain a considerable quantity of tannin have this effect: of which an example has been already mentioned in the action of infusion of galls. Decoctions of cinchona bark decompose it still more effectually. The animal principles do not act on tartar emetic, with the exception of milk, which is slightly coagulated by a concentrated solution. Many vegetable and animal substances, though they do not decompose it, alter the operation of the fluid tests. Thus tea, though it does not effect any distinct decomposition of the salt, will prevent the action of the gall-nut-infusion; and French wine gives a violet tint to the precipitates with that test and with sulphuric acid *. The sulphuretted-hydrogen gas, however, acts, according to Dr Turner, under all circumstances, and always characteristically, whatever the colour of the fluid may be. He found that when transmitted through a diluted solution in tea, porter, broth, and milk, with certain precautions to be mentioned presently, he procured a precipitate which either showed its proper colour at once, or did so at the margin of the filter on which it was collected.

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* *Orfila*, Toxicol. Générale, i. 466.

A single test, however, not being sufficient for medico-legal purposes, it is necessary to apply some process which will give more complete evidence.

Professor Orfila recommends the following compound process. Either the antimony exists in solution, or it has been rendered insoluble by vegetable principles. The suspected matter being filtered, therefore, both the fluid and the matter remaining on the filter must be submitted to analysis. The fluid is to be treated with sulphuretted-hydrogen, and the precipitate collected and reduced with potass in a crucible. The solid part is to be incinerated, and reduced also. In both cases globules of metallic antimony are procured if that metal was present in the mixture *. The metal, if not distinctly visible, is to be acted on by nitromuriatic acid, and the solution treated with sulphuretted-hydrogen in excess, when the usual orange sulphuret is formed †.

This method is liable to some material objections. In the first place, if the fluid is alkaline, the sulphuretted-hydrogen will not act; secondly, I have frequently found that the process of reduction, if on a small scale, does not present distinct metallic globules; and lastly, the double process may be dispensed with.

A much better method of analysis is the following very simple and satisfactory process proposed by *Dr Turner*. The subject of analysis is to be acidulated with a little muriatic and tartaric acids. The former will coägulate various animal principles which may be present. The latter Dr Turner has found to possess the property of readily dissolving all precipitates whatsoever formed by reagents with tartar emetic, except that caused by sulphuretted-hydrogen. Hence the addition of tartaric acid brings the whole antimony into the fluid, and consequently one-half of Orfila's process is dispensed with. The fluid so prepared is to be filtered, and a sulphuret formed and collected in the usual way. Dr Turner found that the next step, the reduction of the sulphuret, cannot be effected on the small scale even in a crucible, much less of course in a tube; and on examining the flux he discovered that a part of the sulphuret escapes decomposition, and that the metal which is reduced is too finely divided to be distinguishable. He was therefore led to propose the process of reduction by hydrogen, (p. 441,) which will develope antimony characteristically from only a tenth part of a grain of the sulphuret. If the stream of gas is slow, the metal remains where the sulphuret was; if the stream is rapid, it undergoes a spurious sublimation, and condenses on the tube either in detached crystals or in the form of a shining crust. When there is much animal or vegetable matter present in the sulphuret, the metal is not always distinctly visible. In that case Dr Turner recommends that it be heated in an open tube, when it oxidates and sublimes in the form of a white powder, which glimmers, but is not crystalline and adamantine like the oxide of arsenic*. A better method, however, is to dissolve the antimony by the action of nitric acid on the mixed material and broken fragments of the tube, and to throw down the orange sulphuret again from the neutralized solution by means of sulphuretted-hydrogen.

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* Toxicol. Gén. i. 481.

† Traité de Méd. Lég. iii. 215, 217.

Dr Turner's method I have repeatedly found to be successful and manageable. But some practice is required to transmit the hydrogen gas with the proper rapidity. The gas ought to be allowed to pass for some time before the spirit-lamp flame is applied, otherwise the oxygen remaining in the apparatus may cause an explosion, or will oxidate the metallic antimony, formed by the reduction of the sulphuret. As soon as the reduction of the sulphuret begins, the tube is blackened on account of the action of the sulphuretted-hydrogen on the lead contained in the glass. This obscures the operations within the tube; but on subsequently breaking it, a metallic button or a sublimate will be easily seen. I have generally found that when the sulphuret is considerable in quantity and the gaseous current slow, the metal remains where the sulphuret was; but if the mass of sulphuret is small and the current rapid, then the metal is sublimed and condensed in minute scaly brilliant crystals.

In a late paper *Orfila* has defended his process against Dr Turner's criticisms, and states, that either in a crucible or (if the quantity of sulphuret is small) in a tube heated by the blowpipe with a "lampe à quatre mêches" globules may be procured; and that he has procured them in this manner from a sixth part of a grain with the black flux, or with a mixture of charcoal and a little potass[*]. I must remark, however, that I have often tried Orfila's process and always failed to procure distinct globules, unless the heat was intense, and then I have only sometimes succeeded. This process of reduction is certainly precarious; and, notwithstanding what Orfila has said in favour of his own method and against that of Dr Turner, the latter has appeared to me much superior. *Dr O'Shaughnessey*, like Professor Orfila, objects to Dr Turner's process of reduction by hydrogen, that it is precarious and has often failed in his hands. I can only say that it has uniformly appeared to me convenient, manageable, and successful, and that I have never failed to procure a distinct sublimate, even in hasty experiments performed before my class. Dr O'Shaughnessey suggests as a more convenient test of the nature of the sulphuret than the reduction process has appeared to him,—that it be dissolved in nitro-muriatic acid with the aid of heat, that the solution be evaporated to dryness, and the residue acted on by distilled water, upon which an insoluble white powder, the oxide of antimony, is formed. The powder, when dried and heated in a spirit-lamp flame, is described by him as acquiring a bright golden colour[†]. This description, however, may mislead the unpractised chemist. The effect of heat is first to produce a faint glow or combustion, which *Berzelius* says is owing to the passage of the oxide to a higher state of oxidation[‡],—and then to change the colour to pale orange, which becomes again white when the powder cools.

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* Edin. Med. and Surg. Journ. xxviii. 75.

It is almost unnecessary to observe that when the contents of the stomach or vomited matters are the subject of analysis, care must be taken to ascertain that tartar-emetic was not administered as a remedy.

SECTION II.—*Of the Action of Antimony, and the Symptoms it excites in Man.*

There is little peculiarity in what is hitherto known of the symptoms of poisoning with tartar emetic in man. Cases in which it has been taken to the requisite extent by man are rarely met with; and it has seldom remained long enough in the stomach to act deleteriously. But its action on animals would appear from late experiments by *Magendie* to be in some respects peculiar.

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[*] Arch. Gén. de Médecine, xvi. 85.

[†] Lancet, 1830–31, i. 323.

[‡] Lehrbuch der Chemie, ii. 94.

He found that dogs, like man, may take a large dose with impunity, for example half an ounce, if they are allowed to vomit; but that if the gullet is tied, from four to eight grains will kill them in a few hours. His subsequent experiments go to prove that death is owing to the poison exciting inflammation in the lungs. When six or eight grains dissolved in water were injected into a vein, the animal was attacked with vomiting and purging, and death ensued commonly within an hour. In the dead body he found not only redness of the whole villous coat of the stomach and intestines, but also that the lungs were of an orange-red or violet colour throughout, destitute of crepitation, gorged with blood, dense like the spleen, and here and there even hepatized. A larger quantity caused death more rapidly without affecting the alimentary canal; a smaller quantity caused intense inflammation there and death in twenty-four hours; but the lungs were always more or less affected [*].

It is a fact, too, worthy of notice, that in whatever way this poison enters the body its effects are nearly the same. This is shown not only by the researches of Magendie already mentioned, but likewise by the experiments of *Schloepfer*, who found that a scruple dissolved in twelve parts of water and injected into the windpipe, caused violent vomiting, difficult breathing, and death in three days; and in the dead body the lungs and stomach were much inflamed, particularly the former [†]. It farther appears from an experiment related by *Dr Campbell*, that, when applied to a wound, it acts with almost equal energy as when injected into a vein. Five grains killed a cat in this way in three hours, causing inflammation of the wound, and vivid redness of the stomach [‡]. He did not find the lungs inflamed.

Magendie infers from his own researches that tartar-emetic occasions death when swallowed, not by inflaming the stomach, but through means of a general inflammatory state of the whole system subsequent to its absorption,—of which disorder the affection of the stomach and intestines and even that of the lungs are merely parts or symptoms. The later experiments of *Rayer* tend in some measure to confirm these views, by showing that death may occur without inflammation being excited any where. In animals killed in twenty-five minutes by tartar-emetic applied to a wound, he, like Dr Campbell, could find no trace of inflammation in any organ of the great cavities *.

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[*] Mémoire sur l'Emétique, or *Orfila*, Toxical. Gén. i. 469.

[†] De Effectibus liquidorum, &c. p. 32.

[‡] Diss. Inaug. de Venenis Mineral. Edin. 1813. P. 23.

When Tartar-Emetic has been swallowed by man it generally causes vomiting very soon and is all discharged; and then no other effect follows. But if it remains long in the stomach before it excites vomiting, or if the dose be large, more permanent symptoms are sometimes induced. The vomiting recurs frequently, and is attended with burning pain in the pit of the stomach, and followed by purging and colic pains. There is also sometimes a sense of tightness in the throat, which may be so great as to prevent swallowing. The patient is likewise tormented with violent cramps. Among the cases hitherto recorded none is to be found where notice is taken of pulmonary symptoms, which might be expected to occur if Magendie's experiments on animals are free of fallacy.

The late introduction of large doses of Tartar-Emetic into medical practice having excited some doubt as to its poisonous properties, it becomes a matter of some moment to procure positive facts on the subject. The following cases may therefore be quoted, which will satisfy every one that this substance is sometimes an active irritant.

The first case is particularly interesting from its close resemblance to cholera. It occurred in consequence of an apothecary having sold tartar-emetic by mistake for cream of tartar. The quantity taken was about a scruple. A few moments afterwards the patient complained of pain in the stomach, then of a tendency to faint, and at last he was seized with violent bilious vomiting. Soon after that he felt colic pains extending throughout the whole bowels, and these were ere long attended with profuse and unceasing diarrhœa. The pulse at the same time was small and contracted, and his strength failed completely; but the symptom which distressed him most was frequent rending cramps in the legs. He remained in this state for about six hours, and then recovered gradually under the use of cinchona and opium; but for some time afterwards he was liable to weakness of digestion *.

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* Diction. de Méd. et de Chir. Pratiques, *Art.* Antimoine, iii. 69.

The next case to be mentioned, where the dose was forty grains, proved fatal, although the person vomited soon after taking it. The symptoms illustrate well the compound, narcotico-acrid action of the tartar emetic, often observed in animals. The poison was taken voluntarily. Before the person was seen by *M. Récamier*, who relates the case, he had been nearly two days ill with vomiting, excessive purging, and convulsions. On the third day he had great pain and tension in the region of the stomach, and appeared like a man in a state of intoxication. In the course of the day the whole belly became swelled, and at night delirium supervened. Next day all the symptoms were aggravated; towards evening the delirium became furious; convulsions followed; and he died during the night, not quite five days after taking the poison †.

Severe effects have also been caused by so small a dose as six grains. A woman, who swallowed this quantity wrapped in paper, was seized in half an hour with violent vomiting, which soon became bloody. In two hours the decoction of cinchona was administered with much relief. But she had severe colic, diarrhœa, pain in the stomach, and some fever, of which symptoms she was not completely cured for five days ‡.

Under the head of the treatment another case will be noticed where half a drachm excited severe symptoms, and was probably prevented from proving fatal only by the timely use of antidotes.

While these examples prove that tartar emetic is occasionally an active irritant in the dose of a scruple or less, it must at the same time be admitted to be uncertain in its action as a poison. This appears from the late employment of it in large doses as a remedy for inflammation of the lungs. The administration of tartar emetic in large doses was a common enough practice so early as the seventeenth century, and was also occasionally resorted to by physicians between that and the present time. But it is only in late years that, by the recommendations of *Professor Rasori* of Milan * and *M. Laennec* of Paris, it has again become a general method of treatment. According to this method, tartar emetic is given to the extent of twelve, twenty, or even thirty grains a day in divided doses; and not only without producing any dangerous irritation of the alimentary canal, but even also not unfrequently without any physiological effect whatever. Serious doubts were at one time entertained of the accuracy of the statements to this effect published by foreign physicians; but these doubts are now completely dissipated, as the same practice has been tried, with the same results, by many practitioners in Britain. *Professor Rasori* ascribes the power the body possesses of enduring large doses of tartar emetic without injury, to a peculiar diathesis which accompanies the disease and ceases along with it. And it is said, that the same patients, who, while the disorder continues, may take large doses with impunity, are affected in the usual manner, if the doses are not rapidly lessened after the disease has begun to give way. The testimony of *Laennec* on the subject is impartial and decisive. He observes he has given as much as two grains and a half every two hours till twenty grains were taken daily, and once gave forty grains in twenty-four hours by mistake; that he never saw any harm result; and that vomiting or diarrhœa was seldom produced, and never after the first day. The power of endurance he found to diminish, but not as Rasori alleges, to cease altogether, when the fever ceases; for some of his patients took six, twelve, or eighteen grains daily when in full convalescence †. My own observations correspond completely with Laennec's, except as to the effects of large doses during convalescence, of which effects I have had no experience. I have certainly seen from six to twenty grains, when given daily in several doses of one or two grains, check bad cases of peripneumony and bronchitis, without causing vomiting or diarrhœa after the first day, and also without increasing the perspiration. At the same time I have twice seen the first two or three doses excite so violent a purging and pain in the stomach and whole bowels, that I was deterred from persevering with the remedy. I have never witnessed any good result from this treatment in the continued fever of Edinburgh; but I have repeatedly found that the doses mentioned above did not in that disease cause any symptoms of irritation in the stomach or intestines.

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* Orfila, Toxicol. i. 474.

† Ibid. i. 478.

‡ Bulletins des Sciences Médicales, xvii. 243.

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* Edin. Medical and Surgical Journal, xxii. 227.

† *Laennec*, Auscultation Médiate, i. 493.

The large quantities now mentioned have even been sometimes given in a single dose with nearly the same results. *Dr Christie* mentions in his Treatise on Cholera that he sometimes gave a scruple in one dose with the effect of exciting merely some vomiting and several watery stools. But he admits that in one instance symptoms were induced like those of a case of violent cholera *.

The preceding facts, unless Rasori's explanation be admitted, are very perplexing, and completely at variance with the facts previously quoted in support of the poisonous effects of tartar emetic. On a full consideration of the whole circumstances, however, I conceive the conclusion which will be drawn is, that this substance is not so active a poison as was till lately supposed;—that in the dose of four, six, or ten grains it may cause severe symptoms, but is very uncertain in its action,—and that although there appears to be some uncertainty in the effects of even much larger doses, such as a scruple, yet in general violent irritation will then be induced, and sometimes death itself.

An instance is related in the Journal Universel of a man who, while in a state of health, swallowed seventeen grains, and then tried to suffocate himself with the fumes of burning charcoal. He recovered, though not without suffering severely from the charcoal fumes; but he could hardly be said to have been affected at all by the tartar emetic †. Here the inactivity of the poison was probably owing to the narcotic effects of the fumes.

The effects of tartar emetic on the skin are worthy of notice; but they have not yet been carefully studied. Some facts tend to show that even its constitutional action may be developed through the sound skin. *Mr Sherwen* attempted to prove by experiments on himself and two pupils, that five or seven grains in solution will, when rubbed on the palms, produce in a few hours nausea and copious perspiration [*]. His observations have been confirmed by *Mr Hutchinson* [†]. But *Savary*, a French physician, on repeating these experiments, could remark nothing more than a faint flat taste and slight salivation [‡]; and *Mr Gaitskell* could not remark any constitutional effect at all [§]. Sometimes it has appeared to cause severe symptoms of irritant poisoning when used in the form of ointment to excite a pustular eruption. An instance of this has been described in a late French Journal [||]. Nay, in the Medical Repository there is a case, in which the external use of tartar emetic ointment is supposed to have been the cause of death. The subject was an infant, two years old, who, soon after having the spine rubbed with this ointment, was seized with great sickness and frequent fainting, which in forty-eight hours proved fatal [¶]. Considering the numerous opportunities which medical men have had of witnessing the effects of tartar emetic applied in the same manner, and that these are solitary cases, doubts may be entertained whether the irritant symptoms in the one case, or the child's death in the other, were occasioned in the way supposed.

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* On the Nature and Treatment of Cholera, p. 24.

† *Renauld* in Journ. Univ. des Sciences Médicales, xvii. 120.

Although the constitutional action of tartar emetic is not easily developed through the sound skin, its local effects are severe and unequivocal. When applied to the skin it does not corrode, but excites inflammation, on which account it is much used instead of cantharides. It does not blister; but after being a few days applied, it brings out a number of painful pustules; if it be persevered in, the skin ulcerates; and if it be applied to an ulcerated surface it causes profuse suppuration, or sometimes even sloughing.

Tartar emetic is one of the substances which appear to possess the property of acting on the infant through the medium of its nurse's milk. I do not know, indeed, what may be the general experience on this point; but a French physician, *M. Minaret*, has published a clear case of the kind, in the instance of a young woman who was taking tartar emetic for pleurisy, and whose infant was attacked with a fit of vomiting immediately after every attempt to suck the breast[*].

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[*] Mem. of Lond. Med. Soc. ii. 386.

[†] Ibidem, v. 81.

[‡] Corvisart's Journ. de Méd. xxvi. 221.

[§] Mem. of Lond. Med. Soc. iv. 79.

[||] Journal de Chimie Médicale, iv.

[¶] Lond. Med. Repos. xvi. 357.

SECTION III.—*Of the Morbid Appearances produced by Antimony.*

The morbid appearances caused by Tartar Emetic have not been often witnessed in man.

In M. Récamier's case there were some equivocal signs of reaction in the brain. The organs in the chest were healthy. The villous coat of the stomach, except near the gullet, where it was healthy, was every where red, thickened, and covered with tough mucus. The whole intestines were completely empty. The duodenum was in the same state as the stomach; but the other intestines were in their natural condition.

M. Jules-Cloquet observed in the body of a man who died of apoplexy, and who in the course of five days had taken forty grains of tartar emetic, without vomiting or purging,—that the villous coat of the stomach had a deep reddish-violet colour with cherry-red spots interspersed; and that the whole small intestines were of a rose-red tint spotted with cherry-red[†].

The only other dissection I have seen noticed is one by *Hoffmann*. He says that in a woman poisoned by tartar emetic he found the stomach gangrenous, and the lungs, diaphragm, and spleen as it were in a state of putrefaction[‡]. Little credit can be given to this description.

In animals *Schloepfer* found the blood always fluid[§].

SECTION IV.—*Of the Treatment of Poisoning with Antimony.*

The treatment of poisoning by tartar emetic is simple.—If vomiting has not taken place before the physician reaches the patient, he should make him swallow large draughts of warm water, and tickle the throat. But while that is doing, he should also prepare without loss of time some vegetable decoction which possesses the power of decomposing the poison; and none is better or more likely to be at hand than a decoction of bark, particularly yellow-bark. The tincture is also a good form for administering this antidote. The administration of bark has been found useful even after vomiting has continued for some length of time, probably because a part of the poison has nevertheless remained undischarged. Before the decoction is ready, it is useful to administer the bark in powder.—When there is reason to believe that the patient has vomited enough, and that a sufficient quantity of the bark has been taken, opium is evidently indicated and has been found useful; but venesection may be previously necessary if the signs of inflammation in the stomach are obstinate.

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[*] London Medical Gazette, xiii. 496.

[†] *Orfila*, Toxicol. Générale, i. 480.

[‡] De Medicamentis Venenorum vim habentibus. Opera Omnia, T. 1. p. ii. 213.

[§] Diss. Inaug. de Effectibus liquidorum, &c. p. 32.

The following case related by *M. Serres* was probably cured by the cinchona. At all events, the effect of the antidote was striking.—A man purchased half a drachm in divided doses at different shops, and swallowed the whole in a cup of coffee. Very soon afterwards he was attacked with burning pain in the stomach, convulsive tremors, impaired sensibility,—afterwards with cold clamminess of the skin, hiccup, and some swelling of the epigastrium, but not with vomiting. Decoction of cinchona was given freely. From the first moment almost of its administration he felt relief, and began to sweat and purge. Next morning, however, he vomited, and for some days there were evident signs of slight inflammation in the stomach; nay for a month afterwards he had occasional pricking pains in that region; but he eventually recovered *. Another and more pointed case has been related by *Dr Sauveton* of Lyons. A lady swallowed by mistake for whey a solution of sixty grains of tartar emetic. In ten minutes she was seen by her physician, and at this time vomiting had not commenced. Tincture of bark was immediately given in large doses. No unpleasant symptom occurred except nausea and slight colic †.

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* *Orfila*, Toxicol. Générale, i. 475.

† Bulletins des Sciences Médicales, vi. 259.

CHAPTER XVII.

OF POISONING WITH TIN, SILVER, GOLD, BISMUTH, CHROME, AND ZINC.

SEVERAL other metallic compounds produce effects analogous to those of the preparations of arsenic, copper, mercury, and antimony. But they may be passed over shortly; because they are little known as poisons, and it is therefore only necessary that their existence and leading properties be mentioned. They are the compounds of tin, silver, gold, bismuth, chrome, and zinc.

Of Poisoning with Tin.

The muriates of *Tin* are used in the arts of colour-making and dyeing, and the oxide of tin forms part of the putty powder used for staining glass and polishing silver plate.

There are two muriates, the protomuriate and permuriate, or protochloride and bichloride, as they are sometimes called. They both form acicular crystals, which are very soluble. It is needless to notice their tests or chemical history; but in order that the following account of their effects on man and animals may be understood, it is necessary to mention, that they are decomposed by almost all vegetable infusions and animal fluids.

With regard to the action of the hydrochlorate of tin, Orfila found, that a solution of six grains injected into the jugular vein of a dog killed it in one minute,—that two grains caused death by tetanus in fifteen minutes,—and that so small a quantity as half a grain caused death in twelve hours, the only symptoms being somnolency and catalepsy or fixedness of position.

To these dreadful effects when introduced into the blood, its effects when swallowed are not nearly proportionate. From eighteen to forty-four grains killed dogs in one, two, or three days, efforts to vomit and great depression being the only symptoms; and after death the stomach was found excessively inflamed, and sometimes ulcerated.—Its effects when applied externally are still less violent. Two drachms applied to a wound merely caused violent inflammation and sloughing of the part, and death in twelve days, without any internal symptom during life or appearance after death *.

These phenomena, considered along with the violent symptoms excited when the poison is injected into the veins, show that when swallowed or applied outwardly, it acts only as a local irritant.

The oxide of tin, according to the experiments of Orfila, is also poisonous when swallowed, but is not so active as the hydrochlorates. According to *Schubarth* it is quite inactive, for he gave an entire drachm to a dog without being able to observe any effect from it whatever †. This is what would be expected considering its extreme insolubility.

The metal has been proved by Bayen and Charlard to be inactive. It has been given expressly to dogs without any effect being observed; and it is given in large doses to man for worms, without detriment.

The only cases of poisoning with the preparations of tin which I have yet seen, are a set furnished to Orfila by one of his friends, and briefly related in his Toxicology. Several persons in a family took the hydrochlorate, in consequence of the cook having mistaken a packet of it for salt and dressed their dinner with it. They had all colic, some of them diarrhœa; none vomited; and all recovered in a few days ‡.

Little need be said of the morbid appearances. Besides the signs of violent irritation caused by the poisons of tin in common with other irritants, Orfila always found in dogs a peculiar tanned appearance of the villous coat of the stomach.

Of Poisoning with Silver.

Of the preparations of *Silver*, the only one which requires notice is the Nitrate or Lunar Caustic.

It exists in two forms,—crystallized in broad, transparent, colourless tables,—and fused into cylindrical, crystalline, grayish pencils. Both forms are essentially the same in chemical nature.—The most convenient tests are, 1. *Hydrochloric acid*, or any hydrochlorate, which even in a state of extreme dilution causes with it a dense white precipitate, passing, under exposure to light, into dark brown; and 2. *Ammonia*, followed by the solution of oxide of arsenic: If the nitrate of silver is not too much diluted it gives a dark brown precipitate with ammonia, soluble, however, in an excess of that alkali; and when the solution has thus been restored arsenic throws down a lively yellow precipitate, passing rapidly to brown, if left exposed to the light.

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* Toxicologie Générale, i. 555.

† *Horn's* Archiv für Medizinische Erfahrung, 1823, ii. 415.

‡ Toxicol. Gén. i. 559.

Most organic substances, but in particular all animal fluids, with the exception of gelatin, decompose nitrate of silver, as they do hydrochlorate of tin.

It appears from the experiments of Orfila, that, like hydrochlorate of tin, the nitrate of silver is a deadly poison when introduced into the veins, but by reason of its facility of decomposition it cannot enter the blood through any of the ordinary channels in a quantity sufficient to develope its remote action. When two grains in solution were injected into the jugular vein of a dog it died in six minutes, difficult respiration being the chief symptom; the third part of a grain caused death in four hours and a half, violent tetanus having preceded death; and in both animals the blood in the heart was found very black and the lungs gorged, or vivid red. To this violent action its effects through the medium of the stomach bear no proportion or resemblance; and consequently the poison cannot enter the blood through that channel. When twelve grains were introduced into the stomach in the solid state, its effects were so slight as not to be distinguishable from those of the ligature on the gullet practised to prevent its discharge by vomiting. When introduced in a state of solution, however, and in a larger dose, in the dose of 36 grains, for example, it is more energetic. Death ensued in thirty-six hours, but without any particular symptoms; and in the dead body the villous coat of the stomach was found generally softened, and corroded near the pylorus by little grayish eschars like those formed by this poison on the skin *.

Hence it appears that nitrate of silver does not act remotely, but simply as a local irritant and corrosive; the corrosion it produces is incompatible with its absorption. This inference is farther confirmed by the experiments of *Schloepfer*, on its effects when introduced into the trachea: He found that it caused inflammation of the windpipe, and pneumonia passing on to hepatization of the lungs, but no symptom referrible to a remote action [*]. Its pure corrosive properties have long pointed it out to the surgeon as the most convenient of all escharotics.

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* Toxicol. Générale, i. 581.

Although when swallowed in large doses the nitrate of silver cannot be absorbed into the system, it probably enters the blood when taken in frequent small quantities. At least it is not easy to account otherwise for the singular blueness of the skin, sometimes observed after the protracted use of lunar caustic as a remedy for epilepsy and other diseases [†]. The effects of the poison on the constitution in such cases are not very well known. It appears, however, that considerable doses may be taken for a great length of time without injury, and that the first and only unpleasant effects produced by its too free administration are such as indicate simply an injury of the stomach. The only exception to this general statement I have met with is a case by *Wedemeyer*, where, after the remedy had been taken for six months on account of epilepsy, that disease disappeared, and dropsy, with diseased liver at the same time commenced, and soon proved fatal. It is probable, however, that the nitrate of silver had no share in the ultimate event. In this instance the whole internal organs were more or less blue; and metallic silver, it is said, was found in the pancreas, and in the choroid plexus of the brain [‡].

Boerhaave has noticed a case of poisoning with this substance, but in very brief terms. He says it caused gangrene. Schloepfer in his thesis notices a case by Dr Albers of Bremen in which true croup was brought on by a bit of lunar caustic dropping into the windpipe.

The *treatment* of poisoning with the nitrate of silver is obvious. The muriate of soda by decomposing it will act as an antidote; and any signs of irritation left will be subdued by opium.

Of Poisoning with Gold.

Gold in various states of combination was at one time much used in medicine, and an attempt has been lately made to revive its employment.

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[*] De Effect. Liquid. ad vias Aeriferas applic. 1816, Tübingen, p. 33.

[†] London Medico-Chirurgical Transactions, vii. 2. Journal der Praktischen Heilkunde. Juli, 1824.

[‡] *Wibmer.* Die Wirkung, &c. i. 212, from *Rust* und *Casper's* Kritische Repertorium, xix. 454.

Its poisonous properties are powerful, and closely allied to those of the hydrochlorates of tin and nitrate of silver. In the state of hydrochlorate it occasions death in three or four minutes when injected into the veins, even in very minute doses; and the lungs are found after death so turgid as to sink in water. But if swallowed corrosion takes place; the salt is so rapidly decomposed, that none is taken up by the absorbents; and death ensues simply from the local injury [*]. It has been of late a good deal used in medicine in France as an antisyphilitic; but even doses so small as a tenth of a grain have been known to produce an unpleasant degree of irritation in the stomach [†].

In the form of fulminating gold, this metal has given rise to some cases of alarming poisoning, when it used to be employed in medicine. *Plenck* in his Toxicologia says it excites griping, diarrhœa, vomiting, convulsions, fainting, salivation; and sometimes has proved fatal [‡]. *Hoffmann* likewise repeatedly saw it prove fatal, and the most remarkable symptoms were vomiting, great anxiety and fainting. In one of his cases the dose was only six grains [§]. These compounds are now so little met with that they need not be noticed in greater detail.

Of Poisoning with Bismuth.

Bismuth, in its saline combinations, is also an active poison. One of its compounds, the subnitrate or magistery of Bismuth, is a good deal used in medicine and the arts; and the pearl white, one of the paints used in the cosmetic art, is the tartrate of this metal.

The former substance is an active poison. It is got by dissolving bismuth in nitric acid, and pouring hot water over the crystals; a supernitrate being left in solution, and the subnitrate thrown down in the form of a white powder.

Orfila found that the soluble part of fifteen grains of the nitrate, when injected into the jugular vein of a dog, caused immediate giddiness and staggering, and death in eight minutes.

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[*] *Orfila*, Toxicol. Générale, i. 593.

[†] *Magendie*, Formulaire pour les noveaux Medicamens.

[‡] Toxicologia, 241.

[§] Medicina Rationalis Syst. ii. c. 8. Sect. 12.

He also remarked, that forty grains mixed with water and introduced into the stomach, caused all the customary signs of irritation and death in twenty-four hours; and that a great part of the villous coat of the stomach was reduced to a pulpy mass, and likewise exhibited several ulcers *.

Similar effects were produced by the subnitrate; but a larger dose was required. Two drachms and a-half killed a dog in twenty-four hours; and redness and eroded spots were found in the stomach.

Orfila further remarks, that Camerarius of Tübingen once detected the adulteration of wine with the oxide of bismuth, and that the bakers in some parts of England used to render their bread white and heavy by mixing the subnitrate with flour; but he has not stated his authority for this accusation. It may be discovered in any such mixture by calcining the suspected substance in a crucible, and then separating the metallic bismuth by means of nitric acid. The metal may then be detected by reagents. These it is unnecessary to mention in this work. The adulteration of bread, mentioned by Orfila, is very questionable, as there are many methods for affecting the purpose specified by him much more cheaply, and without adding any thing positively deleterious.

The following is the only case with which I am acquainted of poisoning with the preparations of bismuth in the human subject. A man subject to water-brash took two drachms of the subnitrate with a little cream of tartar by mistake for a mixture of chalk and magnesia. He was immediately attacked with burning in the throat, brown vomiting, watery purging, cramps and coldness of the limbs, and intermitting pulse,—then with inflammation of the throat, difficult swallowing, dryness of the membrane of the nose, and a constant nauseous metallic taste,—on the third day with hiccup, laborious breathing and swelling of the hands and face, together with suppression of urine, which was then discovered to have existed from the first. On the fourth day swelling and tension of the belly were added to the pre-existing symptoms, on the fifth day salivation, on the sixth delirium, on the seventh swelling of the tongue and enormous enlargement of the belly; and on the ninth he expired. The urine continued suppressed till the eighth day.—On inspec-

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* Toxicol. Générale, i. 501.

tion of the body it was found that from the back of the mouth to the rectum there were but few points of the alimentary canal free of disease. The tonsils, uvula, pharynx, and epiglottis were gangrenous, the larynx spotted black, the gullet livid, the stomach very red, with numerous purple pimples, the whole intestinal canal red, and here and there gangrenous, especially at the rectum. The inner surface of the heart was bright red. The kidneys and brain were healthy [*].

Of Poisoning with Chrome.

The next metal whose properties deserve notice is *Chrome*. As it is now coming into extensive use in the arts, particularly in the art of dyeing, it is necessary to mention its effects, more especially as they are very singular. They have been ascertained experimentally with great care by *Professor Gmelin* of Tübingen. He found that in the dose of a grain the *Chromate of potass* has no effect when injected into the jugular vein of a dog,—that four grains produced constant vomiting, and death in six days without any other striking symptom,—and that ten grains caused instant death by paralyzing the heart. Its effects, when introduced under the skin, are still more remarkable. It seems to cause general inflammation of the lining membrane of the air-passages. When a drachm was thrust in the state of powder under the skin of the neck of a dog, the first symptoms were weariness and a disinclination to eat. But on the second day the animal vomited, and a purulent matter was discharged from the eyes. On the third day it became palsied in the hind-legs; on the fourth it could not breathe or swallow but with great difficulty; and on the sixth it died. The wound was not much inflamed; but the larynx, bronchi, and minute ramifications of the air tubes contained fragments of fibrinous effusion, the nostrils were full of similar matter, and the conjunctiva of the eyes was covered with mucus. In another dog, an eruption appeared on the back, and the hair fell off [†].

When swallowed, the salts of chrome cause inflammation, but not of a violent kind.

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[*] Bulletins des Sciences Méd. xx. 188. From the Heidelberg Klinische Annalen, also *Wibmer*. Die Wirkung der Arzneimittel und Gifte, i. 416.

[†] Versuche über die Wirkungen des Baryts, Strontians, Chroms, &c. auf den thierischen Organismus. 1824.

To these facts may be added another not less singular, which my late colleague Dr Duncan informed me has been observed by the workmen in Glasgow, who use the bi-chromate of potass in dyeing. When this salt was first introduced into the art of dyeing, the workmen who had their hands often immersed in its solution were attacked with troublesome sores on the parts touched by it; and the sores gradually extended deeper and deeper, without spreading, till they sometimes actually made their way through the arm or hand altogether *.

Of poisoning with Zinc.

The compounds of *Zinc*, which have been long used in considerable doses in medicine, have sometimes occasioned serious and even fatal effects. Partly on this account, and partly because one of them, the sulphate of zinc, being the emetic most commonly used in the treatment of poisoning, is apt to complicate various medico-legal analyses, it will be proper to notice both its physiological properties and the mode of detecting it by chemical means.

The only important compound of this metal is the sulphate or *white vitriol*. As usually sold in the shops, it forms small, prismatic crystals, transparent, colourless, of a very styptic metallic taste, and exceedingly soluble in water. That which is kept by the apothecary is tolerably pure; but the ordinary salt of commerce commonly contains an admixture of sulphate of iron, by the presence of which the natural action of the tests for zinc is materially modified.

The solution of the pure salt is precipitated white by the *caustic alkalis*, an oxide being thrown down, which is soluble in an excess of ammonia. The *alkaline carbonates* also precipitate it white, the carbonate of ammonia being the most delicate of these reagents. The precipitate is soluble in an excess of carbonate of ammonia, and is not thrown down again by boiling. The precipitate produced both by the alkalis and by their carbonates becomes yellow, when heated nearly to redness; and on cooling it becomes again white. This is a characteristic property, by which the oxide of zinc may be known from most white powders: It has been already observed, however, that the oxide of antimony is similarly affected (446).

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* Ed. Med. and Surg. Journ. xxvi. 133.

The *ferro-cyanate of potass* also causes a white precipitate. A stream of *sulphuretted-hydrogen* likewise causes a white precipitate, the sulphuret of zinc, the colour of which distinguishes the present genus of poisons from all those previously mentioned, as well as from the poisons of lead. The precipitate is apt to be suspended till the excess of gas is expelled by ebullition. The action of this test will not distinguish sulphate of zinc from the salts of the peroxide of iron, by which white sulphur is disengaged from the gas in consequence of the peroxide of iron being reduced to the state of protoxide. The same decomposition takes place wherever there is free chlorine, as in many impure samples of muriatic acid.

When the sulphate of zinc contains iron, the alkalis throw down a greenish-white precipitate, the alkaline carbonates a grayish or reddish-white, the ferro-cyanate of potass a light-blue, but sulphuretted-hydrogen the usual white precipitate. Tincture of galls, which merely renders the pure salt hazy, causes a deep violet coagulum if there is any ferruginous impurity.

The sulphate of zinc is acted on by albumen and milk precisely in the same manner as the sulphate of copper. The salt is decomposed, and the metallic oxide forms an insoluble compound with the animal matter.

When the sulphate of zinc has been mixed with vegetable and animal substances, the action of the tests mentioned above is modified. In such circumstances I have found the following process convenient.

The mixture being strained through gauze, it is to be acidulated with acetic acid, and filtered through paper. The acetic acid dissolves any oxide of zinc that may have been thrown down in union with animal matter. The filtered fluid is then to be evaporated to a convenient extent, and treated when cool with sulphuretted-hydrogen gas,—upon which a grayish or white milkiness or precipitate will be formed. The excess of gas must now be expelled by boiling, and the precipitate washed by the process of subsidence and affusion, and collected on a filter. It is then to be dried and heated to redness in a tube. When it has cooled, it is to be acted on by strong nitric acid, which dissolves the zinc and leaves the sulphur. The nitrous solution should next be diluted, and neutralized with carbonate of ammonia; after which the liquid tests formerly mentioned will act characteristically. The effect of carbonate of ammonia, and that of heat on the carbonate of zinc which is thrown down, ought to be particularly relied on.

I have tried this process with the matter vomited after the administration of sulphate of zinc, in a case of pretended poisoning, and found it to answer exceedingly well.

Professor Orfila has furnished the only accurate information hitherto possessed regarding the effects of sulphate of zinc on the animal system *.—He found that dogs might be made to swallow 7½ drachms without any permanent harm being sustained, provided they were allowed to vomit; for in a few seconds the whole poison was invariably discharged, and the animals, after appearing to suffer for four or five hours, gradually recovered their usual liveliness. But the result is different if the gullet be tied: violent efforts to vomit ensue, and death follows in three days, the intermediate phenomena being those of local irritation chiefly, and the appearances in the dead body those of incipient inflammation of the stomach, without corrosion.—When injected into the veins, the effect of sulphate of zinc is much more violent, in an inferior dose. Forty-eight grains occasioned almost instant death; and half the quantity proved fatal in three minutes. Orfila does not appear to have ascertained the cause of death in the last two experiments; for no particular symptom was remarked, except efforts to vomit in the former of the two animals; and in neither was any morbid appearance to be seen.—His experiments, however, when taken together, show that sulphate of zinc, though a moderately active irritant, is more indebted for its activity to a remote operation on some vital organ. The difference between its effects through a mucous membrane and through a vein would have been still greater, if the phenomena in the former instance could have been observed without the ligature on the gullet; but the difference, even as it stands, establishes clearly a remote action of an unascertained nature.

The effects of the preparations of zinc on man in large doses have not been particularly studied. In the dose of a scruple or a drachm, the sulphate is the most immediate emetic we possess; and it is to be inferred, that if larger doses

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* Toxicologie Générale, i. 569.

are rejected, as is the fact, with equal rapidity, they will in general cause no more harm than the medicinal dose.

Nevertheless, some people have suffered severely from overdoses of sulphate of zinc, and a few have even perished. Instead of presenting here a general view of the symptoms, it will be preferable to relate the heads of such cases as have been published.

The first to be mentioned is related by *Foderé*, who, in consequence of the violent symptoms produced, assigns to the present poison very active properties. " A patient of mine," says he, " a custom-house officer, having got from a druggist six grains of sulphate of zinc to cure a gonorrhœa, was attacked with inflammation in the lower belly, attended by retraction of the navel and severe colic, which yielded only to repeated blood-letting, general as well as local, oleaginous emollients, opiates, and the warm-bath [*]." This case is noticed here chiefly to prevent any one from being misled by it, as it has been quoted by other medico-legal authors. For assuredly some other cause must have co-operated before such symptoms could arise; since I have in many cases given the same dose thrice daily for several days, without ever observing more than slight sickness.

Parmentier, the chemist, met with an instance, in which about two ounces of white vitriol in solution were swallowed by mistake. The countenance became immediately pale, the extremities cold, the eyes dull, the pulse fluttering. The patient, a young lady, then complained of a burning pain in the stomach, and vomited violently. But potass being now administered in syrup, the pain ceased, the vomiting gradually abated, and the lady soon recovered completely [†].

In the Journal de Médecine, another instance is related by *M. Schueler*, in which a very large dose did not produce material injury. The symptoms were pain in the stomach and bowels, with vomiting and diarrhœa. They were dispelled in a few hours by the administration of cream, butter, and chalk [‡].

The following is a fatal case recorded by *Metzger*, but it is not a pure example of poisoning with zinc, though accounted such by the relater; for a small quantity of sulphate of copper was mixed with the sulphate of zinc. Three persons in a family took this mixture, which had been given them by a grocer in mistake for pounded sugar. They were all seized with violent vomiting; and a boy twelve years of age died in less than twelve hours [*].

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[*] Médecine Légale, iv. 165.

[†] *Orfila*, Tox. i. 573.

[‡] Journal Générale de Médecine, lvi. 22.

Another and an unequivocal case has been lately recorded in Horn's Archiv from *Mertzdorff's* experience. No part of the history of the symptoms is mentioned, except that there had been vomiting. But Mertzdorff has described carefully the morbid appearances, which are interesting; and he detected the poison in the stomach by a satisfactory analysis [†].

Two other cases, which are presumed to have arisen from the commercial sulphate of zinc, and which proved fatal, have been recently published by *Dr Sartorius* of Aachen; but they do not appear to me to have been satisfactorily traced to this poison, and it is therefore unnecessary to quote them [‡].

It does not appear that workmen who are exposed to the fumes of zinc ever suffer materially. But there is a case in Rust's Magazin, which shows that these fumes are not quite harmless. An apothecary's assistant, while preparing philosopher's wool, incautiously filled the whole laboratory with it. The same day he was seized with tightness in the chest, headach, and giddiness; next morning with violent cough, vomiting, and stiffness of the limbs; on the third day with a coppery taste in the mouth, some salivation, gripes, and such an increase of giddiness that he could not stand. He was then freely purged, after which a fever set in, ending in perspiration; and he got well in three weeks [§].

From these cases, and the experimental researches of Orfila, it is clear that the preparations of zinc, though not very active poisons, are nevertheless far from being innocuous. We are not acquainted with their effects when long and habitually introduced into the body in small quantities. About the time when physicians began to study with care the dangerous consequences of employing lead and copper in the manufacture of culinary vessels, it was conceived by some that zinc might prove a safe substitute. It was farther imagined by some military economists in France, that zinc might be profitably used instead of tinned iron in the manufacture of canteens and other articles of camp equipage, because the worn and damaged vessels would sell as old metal at little short of their original price, while tinned iron as old metal bears no value at all. But from the experiments of *Deyeux* and *Vauquelin* it subsequently appeared, that in the course of many culinary operations zinc is more liable to be attacked than either copper or lead;—that water left for some time in zinc vessels oxidates them, and acquires a metallic taste;—that if water acidulated with vinegar or lemon-juice is boiled in zinc, a solution is formed, in which the metal may be detected by its tests;—and that sea-salt, sal-ammoniac, and even butter, have the power of dissolving it also *. Some singular inquiries, however, were afterwards prosecuted by *Bayen* and *Dejaer* among the Spanish prisoners at Liége, with the view of proving, that frequent small quantities of zinc dissolved in the manner mentioned, and habitually taken with the food, have no injurious tendency; that even in large doses it can hardly be accounted poisonous, as it merely gives rise to vomiting and slight diarrhœa; and that an adulteration to such an amount would always betray itself by its strong disagreeable taste †. These are certainly curious facts, though not quite satisfactory. But it is unnecessary to inquire minutely into their validity; for, independently of all other considerations, vessels constructed of zinc are too brittle for domestic purposes. With regard to the effects of frequent small doses of sulphate of zinc, the only positive information I can communicate is, that I have often given medicinally from three to six grains thrice every 24 hours for eight, twelve, or fourteen days, without observing any particular effect except in some persons sickness when the largest doses were taken.

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[*] Materialien für die Staatsarzneikunde, i. 122.

[†] *Horn's* Archiv, 1824, ii. 259.

[‡] Buchner's Repertorium für die Pharmacie, xxvii. 317, and xxxiii. 104.

[§] Magazin für die gesammte Heilkunde, xxi. 563.

Sulphate of zinc is said to have proved fatal when applied externally. In *Pyl's* Memoirs there is a case of this nature, which was attributed to sulphate of zinc having been used as a lotion for a scabby eruption on the head. The subject was a child, six years old, and otherwise healthy. The wash, which was a vinous solution, had not been long applied before the child complained of acute burning pain of the head, which was followed by vomiting, purging, convulsions, and death in five hours. The cause of these symptoms, though the particulars of the case were ascertained judicially by an able medical jurist, *Dr Opitz* of Minden, is nevertheless very doubtful, as daily use is made of the salt for similar purposes without any such effect. Appearances of congestive apoplexy were found within the skull; and the reporter ascribes death to the wash having produced repulsion of the cutaneous disease, and determination of blood to the head *.

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* Annales de Chimie, lxxxvi. 59.

† *Orfila's* Toxicologie, i. 567, from the *Procès-verbal* of the public meeting of the Society of Liége in 1813.

The only opportunities which have occurred of observing the morbid appearances after poisoning with sulphate of zinc taken internally, are the cases by *Metzger* and *Mertzdorff.*

In the former, which was a mixed case, the only appearances of note were slight inflammation in the stomach, and excessive gorging of the lungs with fluid blood, from which *Metzger* oddly enough concludes that the child was suffocated by the vomiting.

In the latter case, *Mertzdorff* found the stomach and intestines, but particularly the intestines contracted,—their outer surface healthy,—the inner membrane of the stomach grayish-green, with several spots of effused blood, and greenish, fluid contents,—the inner membrane of the small intestines similarly spotted,—the rest of the body quite natural. It has been already mentioned that Mertzdorff detected the poison in the body. He found it not only in the contents, but likewise in the coats of the stomach and intestines. His process of analysis was somewhat similar to that which is recommended above, but is unnecessarily complicated.

A short notice may here be added of the toxicological effects of the rarer metals.—Oxide of *Osmium* is nearly as active as arsenic, for a grain and a-half will kill a dog in a few hours by the stomach, and in one hour through a vein. Twelve grains of hydrochlorate of *Platinum* will kill a dog within a day through the stomach, with symptoms of pure irritation; and so will half that quantity through a vein.—The hydrochlorates of *Iridium* and *Rhodium* are rather less active.—The hydrochlorate of *Pal-*

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* Aufsätze und Beob. ii. 12.

ladium is equally powerful when introduced into the stomach, and much more so through a vein, for two-thirds of a grain will kill dogs in a minute.

The salts of other metals appear less active.—*Molybdenum*, in the form of molybdate of ammonia, seems a feeble poison; thirty grains killed a rabbit in two hours, but produced in dogs merely some vomiting and purging, and ten grains injected into the jugular vein did not prove fatal.—*Manganese* is likewise a feeble poison, but has peculiar effects. A drachm of the sulphate killed a rabbit in an hour. Thirty grains swallowed by a dog had no effect. Two drachms thrust into the cellular tissue had no effect. Twelve grains injected into a vein occasioned death in five days: and in the dead body, the stomach, duodenum, and liver, were found much inflamed. The manganesic acid appears also to act on the liver, but is a feeble poison. A rabbit received two drachms in three days in doses of ten or fifteen grains, without presenting any symptom except increased flow of urine. Being then killed, the liver was found soft, at one part bright-red, elsewhere dark-brownish-red, and it yielded manganese by incineration.—*Uranium* is an active poison when injected into a vein, for three grains of the muriate proves fatal instantly; but dogs may swallow fifteen, or from that to sixty grains without any other effect except slight vomiting.—*Cobalt* is more active. Thirty grains of the oxide occasion death in a few hours through the stomach. Twenty-four grains of the muriate applied to the cellular tissue excite vomiting. Three grains of sulphate injected into a vein prove fatal in four days. —*Tungsten*, *Cerium*, *Cadmium*, *Nickel*, *Titanium*, and *Iron*, can scarcely be considered poisons. *Tungstate* of ammonia in the dose of a drachm had no effect when swallowed by a dog; forty grains of tungstate of soda, which is more soluble, operate as an emetic; but this dose will prove fatal to rabbits in a few hours.—A drachm of the muriate of *Cerium* had little or no effect on a dog, and half that dose had no effect on a rabbit.—The oxide of *Cadmium* in the dose of twenty grains made a dog vomit; and ten grains had no effect at all.—Twenty grains of
phate of *Nickel* made a dog vomit; forty grains applied
cellular tissue had no effect at all on the general constit
but ten grains injected into the jugular vein occasioned
diate death.—A drachm of *Titanic* acid had no effect on

—The effects of *Iron* will be noticed in an appendix to the class of Irritant poisons.

For all these facts, with the exception of those relative to cadmium and manganesic acid, the toxicologist is indebted to *Professor Gmelin*[*] of Tübingen. The effects of cadmium were determined by *Professor Schubarth* of Berlin[†], those of manganesic acid by *Professor Hünefeld* of Greifswalde[‡].

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[*] Versuche über die Wirkungen des Baryts, &c. Heidelberg, 1824.

[†] Journal der praktischen Heilkunde, lii. 101.

[‡] Archiv für medisinische Erfahrung, 1830. ii.

CHAPTER XVIII.

OF POISONING WITH LEAD.

POISONING with Lead is a subject of great consequence in Medical Police, as well as Medical Jurisprudence. Its preparations have been used for the purpose of intentional poisoning. At the Taunton Assizes in March 1827 a servant-girl was tried for attempting to administer sugar of lead to her mistress in an arrow-root pudding: and although the charge was not made out, it appeared from the prisoner's confession that she really had made the attempt. Sugar of lead has also been often taken by accident.

In relation to Medical Police lead is a subject of great importance. This metal is used in so many forms, and in so many of the arts, and its effects when gradually introduced into the body are so slow and insidious, that instances of its deleterious operation are frequently met with. Such accidents, indeed, are much less common now, than they used to be before the late improvements in chemistry. But they are still sufficiently frequent to render it necessary for the toxicologist to investigate the properties of lead attentively.

SECTION I.—*Of the Chemical History and Tests for the Preparations of Lead.*

The physical characters of lead in its metallic state are familiar to every one. It is easily known by the dull bluish-gray colour it assumes when exposed some time to the air, by the brilliant bluish-gray colour of a fresh surface, and by the facility with which it may be cut. The compounds which require particular notice are four in number, Litharge, Red Lead, White Lead, Sugar of Lead, and Goulard's extract. The three first are very much used by house-painters and glaziers, the two last are extensively employed in surgery, and the sugar of lead is also used in many of the arts.

1. *Of Litharge and Red Lead.*

Litharge is the protoxide of lead in a state of semivitrification. *Red Lead* is the deutoxide. The former is generally in the form of a grayish-red heavy powder; the latter in the form of a bright red powder approaching in colour to vermilion. They may be known by their colour;—by their becoming black when suspended in water and treated with a stream of sulphuretted-hydrogen gas;—and by litharge being entirely, and red lead partly soluble in nitric acid, and forming a solution which possesses the properties to be mentioned presently. The chemical actions concerned in these changes are obvious, except in the instance of nitric acid on red lead. Here a part of the deutoxide parts with some of its oxygen to become the protoxide which is dissolved; and the disengaged oxygen unites with the remaining deutoxide, converting it into a brown tritoxide, which is not soluble in the acid.

2. *Of White Lead.*

White Lead, which is the carbonate of the metal, is in the form of a heavy snow-white powder, or in white chalk-like masses; and may be known by its being blackened like the two former compounds by sulphuretted-hydrogen,—by being soluble with effervescence in nitric acid,—and by becoming permanently yellow when heated to redness, in consequence of the expulsion of its carbonic acid, and its conversion into protoxide. These tests, however, apply with exactness only to the pure carbonate, in which state white lead is not often met with in the shops. It is very generally adulterated with some sulphates, in consequence of which it is only partially acted on by nitric acid, and does not become distinctly yellow under a strong red heat. Dutch white-lead contains no less than between 78.5 and 25 per cent. of impurities insoluble in nitric acid, Venetian white-lead from 11 to 14.5 per cent, Munich white-lead between 1 and 7.5 per cent [*]. I have examined one specimen from the workshop of the best employed house-painter in this city which was quite pure.

3. *Of Sugar of Lead.*

The *Sugar of Lead* is the acetate of the metal. It is sold in the form either of a white heavy powder, or of aggregated masses of long four-sided prismatic crystals. It has a sweetish astringent taste, and a slight acetous odour. It is very soluble.

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[*] *Buchner's* Repertorium für die Pharmacie, xxxviii. 125.

When in the solid state, it may be known by its solubility in water, and by the effects of heat. It first undergoes the aqueous fusion, then abandons a part of its acid empyreumatized, as may be perceived by the smell, next becomes charred, and finally the oxide of lead is reduced to the metallic state by the charcoal of the acid. The best way of effecting its reduction on the small scale is to char it, and then direct on the mass the point of a blowpipe-flame: in an instant globules of lead are developed. It is not easily reduced in a tube; at least I have never been able to succeed in that way.

In the fluid state the acetate of lead, as well as all its soluble salts, may be detected by the following system of reagents, —*sulphuretted-hydrogen, chromate of potass, hydriodate of potass*, and *metallic zinc*,—which are the best of the numerous reagents which have been proposed.

1. *Sulphuretted-hydrogen gas* causes a black precipitate, the sulphuret of lead. This is a test of extreme delicacy; and it acts in whatever state of combination the lead exists, whether fluid or solid.

It is preferable to the hydrosulphate of ammonia as a medico-legal test; for, as Fourcroy observed, the hydrosulphate of ammonia acts on many sound wines as if they contained lead *, while the sulphuretted-hydrogen never causes with them a black precipitate, unless they contain either lead or some other metallic impregnation.—It must be remembered that many other metallic solutions, such as those of mercury, copper, silver and bismuth, yield a black precipitate with this test.

2. *Chromate of potass*, both in the state of proto-chromate and bichromate, causes a fine gamboge-yellow precipitate, the chromate of lead. For the characteristic action of this reagent, it is desirable that the suspected liquid be neutral.—It forms with solutions of the sulphate of copper a precipitate nearly of the same colour as the chromate of lead.

3. *Hydriodate of potass* causes also a lively gamboge-yellow precipitate, the iodide of lead. The action of this test is impaired in delicacy by a considerable excess of nitric acid, or acetic acid. These acids cause a yellow coloration with the test, though no lead be present.

4. If the solution of lead is not too diluted, *a piece of zinc*

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* Mém. de l'Acad. des. Sc. 1787, 281, sur les vins lithargyriés.

held for some time in it displaces the lead, taking its place in the solution; and the lead is deposited in the form of a crystalline arborescence. This is a very characteristic test; and also one of much delicacy; for I have found a small thread of zinc will very easily detect a twentieth part of a grain of lead dissolved in the form of acetate in 20,000 parts of water.—It acts also on the nitrate of lead. Its action is impaired or prevented by an excess of acetic or nitric acid.

These tests are amply sufficient for determining the presence of lead in a solution, provided they act characteristically. Others have been also used, however; and it is therefore right to notice them cursorily.

The *alkaline carbonates* throw down a white precipitate in a very diluted solution of lead. This test is ineligible, because the alkaline carbonates precipitate many other salts white. It might be rendered decisive, however, by washing the precipitate thoroughly, suspending it in pure water and transmitting sulphuretted-hydrogen, which blackens it. No other white carbonate is similarly altered except those of bismuth and silver, which are very rare.

The *Soluble Sulphates* likwise cause with solutions of lead a white precipitate, the sulphate of lead. To this test the same objections apply as to the carbonates of the alkalis.

The *Ferrocyanate of potass* causes a white precipitate, the ferrocyanate of lead. This is an objectionable test, as many other substances besides lead are similarly acted on by it.

4. *Goulard's Extract.*

Goulard's extract, the subacetate of lead, is easily distinguished from the acetate or sugar of lead by the effect of a stream of carbonic acid, which throws down a copious precipitate of carbonate of lead. The proper method of analyzing it is to transmit this gas till it ceases to act any longer, and then to subject the precipitate and solution to the tests for carbonate of lead, and acetate of lead. Solutions of the common acetate usually give a scanty white precipitate with carbonic acid, in consequence of containing a faint excess of oxide.

The presence of vegetable or animal matters may either decompose the salts of lead, or materially alter the action of the preceding reagents.

It appears from the experiments of Orfila, that most vegetable infusions possess the power of decomposing them more or less. The acetate furnishes, for example, an abundant precipitate with infusion of galls, or with infusion of tea. Almost all animal fluids, with the exception of gelatin, possess the same property: albumen, milk, bile, beef-tea, all give with it a copious precipitate. In fluids which do not decompose it altogether, the colour of the precipitate formed by the tests is so materially altered, that they cannot be relied on for the detection of lead. The test, however, which undergoes least alteration is the sulphuretted-hydrogen. It will presently be seen that sulphuretted-hydrogen may be applied so as to detect lead in all possible states of mixture.

Before proceeding to that subject, however, some remarks will be required on lead in relation to medical police. Here the various ways in which it is apt to be insidiously introduced into the body, chiefly by the action of chemical agents on metallic lead itself, will come under consideration.

Of the Action of Air and Pure Water on Lead.

It has been already said, that when lead is exposed to the air it becomes tarnished. This arises not from oxidation alone, as some have imagined, but from a thin crust of carbonate of lead being formed; for if the crust be scraped off and immersed in acetic acid, it will be dissolved with brisk effervescence. The formation of carbonate is accelerated by moisture and probably by the presence of an unusual proportion of carbonic acid in the air.

The action of water on lead, which is of much greater consequence, has been made the subject of observation by the curious for many ages. The Roman architect, *Vitruvius*, who, it is believed, flourished in the time of Cæsar and Augustus, forbids the use of this metal for conducting water, because cerusse, he says, is formed on it, which is hurtful to the human body*. *Galen* also condemns the use of lead pipes, because he was aware, that water transmitted through them contracted a muddiness from the lead, and that those who drank such water were subject to dysentery [*]. If we trace the sciences of architecture, chemistry, and medicine downwards from these periods, nothing more will be found than a repetition of the statements of Vitruvius and Galen, with but a few particular facts in support of them, till we arrive at the close of the last and beginning of the present century.

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* Vitruv. de Architectura, L. viii. c. 7. Quot modis ducantur aquæ. Editio Dan. Barbari, 1567, pp. 262, 265.

The first person that examined the subject minutely was *Dr Lambe* of Warwick; who inferred from his researches, that most, if not all, spring waters possess the power of corroding and dissolving lead to such an extent as to be rendered unfit for the use of man, and that this solvent power is imparted to them by some of their saline ingredients [†]. The inquiry was afterwards undertaken more scientifically by *Guyton-Morveau;* who, in opposition to Dr Lambe, arrived at the conclusion, that distilled water, the purest of all waters, acts rapidly on lead by converting it into a hydrated oxide, and that some natural waters, which hardly attack lead at all, are prevented doing so by the salts they hold in solution [‡]. A few years later *Dr Thomson* of Glasgow also examined the subject, and, assenting to Dr Lambe's proposition, that most spring waters attack lead, maintains nevertheless that the lead is only held in suspension, not in solution; and that the quantity suspended in such waters, after they have passed through lead pipes, pumps, or cisterns, is far too minute to prove injurious to those who make habitual use of them [§]. In the first edition of this work an extended account was given of an investigation I made into the whole subject of the action of different waters on lead [‖]. And lastly, some additional observations have been very lately published on the same point by *Captain Yorke* [¶].

The inquiry is of so great practical importance, that I need not offer any apology for reproducing it here in detail, with such additions as ulterior experience and the researches of others enable me to make.

Distilled water, deprived of its gases by ebullition, and excluded from contact with the air, has no action whatever on lead. If the water contains the customary gases in solution, the surface of the metal, freshly polished, becomes quickly dull and white. But if the surface of the water be not at the same time exposed to the air, the action soon comes to a close. When the air, on the other hand, is allowed free access to the water, a white powder appears in a few minutes around the lead; and this goes on increasing till in the course of a few days there is formed a large quantity of white, pearly scales, which partly float in the water, but are chiefly deposited on the bottom of the vessel. In twelve ounces of distilled water, contained in a shallow glass basin, loosely covered to exclude the dust, twelve brightly polished lead rods weighing 340 grains, will lose two grains and a half in eight days; and the lead will then show evident marks of corrosion *. The process of corrosion goes on so long as atmospheric air is allowed to play freely on the surface of the water.

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[*] De Medic. secundum locos, lvii.

[†] Researches into the Properties of Spring Waters, 1803, p. 193.

[‡] Annales de Chim. lxxi. 197. l'an 1809.

[§] Experiments in Scudamore's analysis of Tunbridge Water, 1816.

[‖] A Treatise on Poisons, &c. First Edition, 1829.

[¶] Philosophical Magazine. Third Series. v. 81. 1834.

During these changes, a very minute quantity of lead is dissolved. This is best proved by carefully filtering the water, then acidulating with a drop or two of nitric acid, and evaporating to dryness. A solid and sometimes crystalline residue is thus procured, in which, after expelling the excess of nitric acid by heat, I have never failed to detect lead by dissolving the residue in distilled water, and applying sulphuretted-hydrogen, hydriodate of potass, and chromate of potass to the solution. Frequently, however, as Captain Yorke found, sulphuretted-hydrogen will act on the original water without any such preparation, occasioning first a brown colour, and subsequently a black precipitate. He estimates the quantity when the water is saturated at a 10,000th part.

The lead which is dissolved by the aërated water has appeared to me to be in the form of carbonate. From the twelve ounces of water in the experiment mentioned in the last paragraph, there was procured, by evaporation to dryness in a small glass cup, a tenth of a grain of white crystalline powder, which was permanent in the air, dissolved with effervescence in acetic acid, and did not effervesce with that acid, if previously heated to redness. A considerable proportion of the powder is organ-

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* I have since obtained 120 grains from an ounce of lead in the form of rods, kept for twenty months in 24 ounces of distilled water, covered by a large bell-jar.

ized matter, as it chars under the action of heat. But the effect of acetic acid before and after ignition, is satisfactory evidence that the residue of evaporation contains lead in the form of carbonate. *Captain Yorke*, however, has been led by his experiments to conclude that the lead is dissolved in the form of oxide; and in proof of this observes, that the water which has acted on lead is alkaline, and is rendered turbid by carbonic acid, which is owing to the carbonate then formed being less soluble than the oxide *.

By far the greatest part of the lead, however, which disappears, will be found in the white pearly crystals. This crystalline powder is not,—as stated by Guyton-Morveau, and after him by some systematic writers, a hydrated oxide of lead, but in part at least the carbonate; for it dissolves with brisk effervescence in acetic acid, and carbonic acid gas may be collected by subjecting it to heat in a proper apparatus.

In the last edition of this work, it was stated that the crystalline powder is the common carbonate. But *Captain Yorke*, who set out with supposing that it was the hydrated oxide, has eventually come to the conclusion, that although a carbonate is formed, the carbonic acid present is not in the proportion assigned by chemists to the ordinary carbonate; and he seems inclined to conjecture that the compound is a hydrated carbonate with excess of oxide of lead †. On repeating my experiments, I find that the crystalline powder is certainly a hydrate, and also that it contains less carbonic acid than is required to constitute the oxide in it a common carbonate,—but that the carbonic acid is nevertheless larger in quantity than it appeared to be in the researches of Captain Yorke ‡.

It will be inferred from the preceding facts, that distilled water for economical use should never be preserved in leaden vessels or otherwise in contact with lead. Even the distilled waters of aromatic plants should not be so preserved, because the essential oil which communicates to them their fragrance does not take away the power which pure distilled water possesses of acting on lead. This fact was first announced in the last edition of the present work. An apothecary in Edinburgh requested me to examine a reddish-gray, crystalline, pearly sediment formed copiously in a sample of orange-flower water. I found this to be carbonate of lead coloured by the colouring matter of the water, and obviously produced by the action of the water on lead solder used instead of tin solder, and coarsely and liberally applied to the seams of the copper vessel in which the water had been imported from France. The filtered fluid did not contain a particle of lead. The same observation has been since made by a French pharmaceutic chemist, *M. Barateau*, who seems at a loss, however, to account for the formation of the carbonate of lead *. It appears from an inquiry by *MM. Labarraque and Pelletier* conducted at the request of the prefecture of Paris, that the orange-flower water, which is extensively used there, is often adulterated with lead in solution. They impute this to careless distillation; for then some of the decoction is driven over with the distilled liquid, and consequently produces a fluid which becomes acetous by keeping and dissolves the lead solder of the *estagnons* or copper vessels. Pure orange-flower water does not acidify by keeping †. *M. Chevallier* in a more recent investigation arrived at the same results, and found that few specimens of the orange-flower water of Paris were altogether free of lead ‡ In none of these inquiries have the authors adverted to the action of pure water in forming carbonate of lead.

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* Philosophical Magazine, v. 89.

† Ibidem, v. 85.

‡ I have not yet had leisure to inquire into the cause of the discrepancy subsisting between my own results and the interesting investigations of Captain Yorke. I am at present following out the subject. Meanwhile, I may state it appears to me not improbable, that a hydrated oxide is first formed, and that this is gradually changed to the carbonate.

Of the Action of Solutions of Neutral Salts on Lead.

The property which pure aërated water possesses of corroding lead is variously affected by foreign ingredients which it may hold in solution.

Of these modifying substances none are more remarkable in their action than the neutral salts, which all impair the corrosive power of the water. Considering the important practical consequences which flow from that action,—for it involves no less than the possibility of employing lead for most of the economical purposes to which the ingenuity of man has applied that useful metal,—it is singular that our information on the subject is so vague and meager. Indeed the only experimentalist, who so far as I know has made it an object of attention is *Guyton-Morveau;* and his experiments are imperfect and in some respects erroneous. Having found that distilled water corrodes lead, he proceeded to inquire why no change of the kind takes place in some natural waters; and being aware that most spring and river waters differ from that which has been distilled, chiefly in containing sulphate of lime and muriate of soda, he tried a solution of each of these salts, and discovered that the addition of a certain quantity of either to distilled water takes away from it the power of attacking lead,—that this preservative power is possessed by so small a proportion as a 500th part of sulphate of lime in the water,—and that the nitrates are also probably endowed with the same singular property *. Here his researches terminated.

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* Journal de Chim. Méd. ix. 714.

† Annales d'Hyg. Publ. et de Méd. Lég. iv. 55. 1830.

‡ Journal de Chim. Médicale, ix. 716.

Extending Guyton-Morveau's inquiries to other proportions of the same salts, and likewise to many other neutral salts, I have been led to the conclusion, that all of them without exception possess the power of impairing the action of distilled water on lead. At least I have found this power to exist in the case of sulphates, muriates, carbonates, hydriodates, phosphates, nitrates, acetates, tartrates, arseniates,—which are all the neutral salts I have yet tried.

The degree of this preservative power differs much in different salts. The acetate of soda is but an imperfect preventative when dissolved in the proportion of a hundredth part of the water: white crystals are formed, and the lead loses about a fourth of what is lost in distilled water in the same time. On the contrary, arseniate of soda is a complete preservative when dissolved in the proportion of a 12,000th; and phosphate of soda and hydriodate of potass are almost effectual preservatives in the proportion of a 30,000th part only of the water †. Muriate of soda and sulphate of lime hold a middle place between these extremes, and are both of them much more powerful preservatives than Guyton-Morveau imagined: the former preserves in the proportion of a 2000th to the water, the latter in the proportion of nearly a 4000th. Nitrate of potass is a more feeble preservative than the same author supposed; in fact is little superior to the acetate of soda: In the proportion of a hundredth it prevents the action of the water almost entirely; but if the proportion be diminished to a 160th, the loss sustained by the lead is fully a third of the loss in distilled water.

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* Annales de Chimie, lxxi. 197.

† In distilled water containing a 12,000th of anhydrous *arseniate of soda* three lead rods weighing 71.235 grains became in thirty-three days 71.240; in a solution of a 15,000th the lead, though slightly whitened, retained its weight [illegible]ly, weighing at the end as at the beginning of the experiment 62.622 [illegible] distilled water containing a 35,000th of anhydrous *phosphate of soda,* [illegible] rods, which weighed together 73.949 grains, became in thirty-two days [illegible] and in a comparative experiment with a solution containing a 27,000th [illegible] ed 0.015.

When lead has been exposed for a few weeks to a solution of a protecting salt and has acquired a thin film over its surface, it not only is not acted on by the solution, but is even also rendered incapable of being acted on by distilled water.

The preservative power depends on the acid, not on the base of the salt. The acetate, muriate, arseniate, and phosphate of soda differ exceedingly in power. On the other hand, the sulphates of soda, magnesia, lime, as well as the triple sulphate of alumina and potass, preserve as nearly as can be determined in the same proportion.

When we attempt to ascertain the relative preserving power of the neutral salts, it will appear that those whose acid forms with the lead a soluble salt of lead are the least energetic; while those whose acid forms an insoluble salt of lead are most energetic. The protecting powers of acetate of soda, nitrate of potass, muriate of soda, sulphate of lime, arseniate of soda, and phosphate of soda, are inversely as the solubility of the acetate, nitrate, muriate, sulphate, arseniate, and phosphate of lead. The existence of this ratio might naturally lead to the inference that the protecting power depends simply on the salt in solution being decomposed, so that there is formed on the surface of the lead a thin crust consisting of the oxide of the metal in union with the acid of the decomposed salt, and constituting an insoluble film which is impermeable to aërated water: For example, that phosphate of soda acts in the small proportion of a 30,000th part by forming on the surface of the metal an impermeable film of phosphate of lead, which is known to be one of the most insoluble of all the neutral salts. But this is not altogether a correct statement of the fact.

When the protection afforded is complete, as for example by a 27,000th of phosphate of soda, a 12,000th of arseniate of soda, or a 4000th of sulphate of soda, the lead undergoes no change in appearance or in weight for several hours, or even days. At length the surface becomes dull, then white, and gradually a uniform film is formed over it. This film, examined at an early period, is found to consist of carbonate of lead,—being entirely soluble in diluted acetic acid, although the salt in solution is a sulphate or phosphate. But after a few weeks the carbonate is mixed with a salt of lead, containing the acid of a part of the neutral salt dissolved in the water: If, after five or six weeks' immersion in a preservative solution of phosphate or sulphate of soda, the film on the lead be scraped off and immersed in diluted acetic acid, effervescence and solution take place, but a part of the powder remains undissolved; and if the protecting salt has been the muriate of soda, the whole powder is dissolved, but muriatic acid will be found in solution by its proper test, the nitrate of silver.—In all such protecting solutions the lead gains weight for some weeks; but at length it ceases to undergo farther change, and is not even acted on if removed into distilled water. The crust, when formed thus slowly, adheres with great firmness. The most careful analysis cannot detect any lead, either dissolved in the water, or floating in it, or united with the insoluble matter left on the side of the glass by evaporation. In short, the preservation of the lead from corrosion, and of the water from impregnation with lead, is complete *.

When the protection afforded is not quite complete,—for example in distilled water containing a 4000th of muriate of soda, a 6000th of sulphate of soda, a 15,000th of arseniate of soda, or a 35,000th of phosphate of soda,—besides a powdery crust, small crystals, with several facettes, are sometimes formed on the lead, while, at the same time, a minute white film will very slowly appear on the bottom of the glass, on its side where it is left dry by the evaporation of the water, and likewise on the surface of the water itself. These detached films are composed of the carbonate of lead, with a little of the muriate, sulphate, arseniate, or phosphate of lead, according to the nature of the acid in the alkaline salt which is dissolved in the water. In

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* Sometimes, however, a minute trace of white powder is attached to the bottom of the glass wherever the lead touches it. This is carbonate of lead at first, and afterwards a mixture like that described in the text.

the course of the changes now described, the lead in general no longer gains, but loses weight. The loss, however, is exceedingly small.—No lead can be discovered in solution, if the water before evaporation is carefully filtered.

On progressively trying solutions of weaker and weaker preservative power, it will be remarked, that the quantity of the detached powder, and the proportion of carbonate in it, progressively increase; and likewise, that what is formed on the lead adheres more and more loosely. In distilled water and weak solutions of acetate of soda, or nitrate of potass, the lead never becomes so firmly encrusted, but that gentle agitation of the water will shake off the powder.

It is worthy of notice that, although a small quantity of lead is dissolved by distilled water after it has remained some time in contact with the metal, yet not a trace is ever found in solution where a protecting salt is present.—In solutions even very weakly preservative I never could detect any lead dissolved. Thus, in distilled water containing a 4000th of muriate of soda, or a 160th of nitre, the lead lost weight, and loose crystals of carbonate were formed; yet even after thirty days no lead could be found in solution by the process with which I have always detected it in pure distilled water. (P. 477.) Free exposure to the air is probably in part the cause of this. For it will be seen afterwards that some natural waters in passing through a long course of lead pipes, within which the action goes on without the direct access of the atmosphere, contract an impregnation, which is invisible when the water is newly drawn, but after a few hours' exposure to the air shows itself in the form of a white film and milkiness.

The general result of these experiments appears to be, that neutral salts in various, and for the most part minute, proportions, retard or prevent the corrosive action of water on lead, —allowing the carbonate to deposit itself slowly, and to adhere with such firmness to the lead as not to be afterwards removable by moderate agitation,—adding subsequently to this crust other insoluble salts of lead, the acids of which are derived from the neutral salts in solution,—and thus at length forming a permanent and impermeable skreen, through which the action of the water cannot any longer be carried on.

An important subject of inquiry regards the natural causes by which the preservative power of the neutral salts is impaired. This topic I have not hitherto been able to examine with all the care which is desirable.

From the effect of the water of Edinburgh when highly charged with carbonic acid, I was led to infer in former editions of this work that an unusual quantity of carbonic acid is a counteracting agent. For if Edinburgh water charged with it be corked up with some lead rods in a phial half filled with water, and half with atmospheric air, the lead, which in common Edinburgh water, as will presently be mentioned, hardly loses any of its brilliancy for six or seven days, becomes quite white in twelve or sixteen hours. But subsequent experiments by Captain Yorke seem to him to render this conclusion doubtful; nor do I attach much consequence to the observation just quoted. The point would be best settled by trying the effect of a steady supply of a natural carbonated water.

On the Action of Natural Waters on Lead.

The preceding observations on the action of water on lead may be resorted to for explaining many interesting facts, and correcting some erroneous statements, which have been published by authors as to the corrosion of lead by natural processes.

Rain and Snow-Water.—It has been stated by *Dr Lambe* that Rain-water does not corrode lead, that "its effect is so slight as not to be discernible within a moderate compass of time [*]." But this observation is far from being correct. Rain or snow-water, collected in the country at a distance from houses, and before it touches the earth, being nearly as pure as distilled water, ought to act with almost equal rapidity on lead. I have accordingly found by a comparative experiment with that mentioned in p. 477, that in twelve ounces of snow-water, collected ten miles west from Edinburgh, and at some distance from any house, twelve lead rods weighing 340 grains lost two grains in eight days; and the usual crystals began to form in less than an hour. But when collected in a great city, rain or snow-water is much impaired in activity. Thus in an experiment made with eaves'-droppings collected from the roof of my house in Edinburgh after half an hour of gentle rain from the south-

[*] On Spring Waters, p. 23.

south-east,—the first rain which had fallen for several we there was no action at all. Yet even when collected in city, and in circumstances which at first sight would app very favourable to its action,—for example from eaves pings a few hours after the beginning of a shower,—it re little of its corroding property; and when collected in lik ner after twelve or twenty-four hours' rain, it corrodes as rapidly as distilled water. Thus with four ounces of droppings collected after the shower last alluded to ha tinued four hours, the crystalline powder began to cover tl tom of the glass in five hours, and in nine days three lea weighing fifty-seven grains lost a fifth of a grain. And other experiment made with eaves'-droppings after a day's rain from the north-east, the powder began to form in h hour, and the loss sustained by the lead in thirty-three da a grain and a third, being very nearly what is lost in di water during the same time.

We must obviously be prepared to look for an expla of these differences in the relative purity of the different w Accordingly, in the eaves'-droppings at the beginning shower the nitrates of baryta and silver caused, the former tinct, the latter a faint precipitation, which, as oxalate of nia had no effect, arose from the presence of alkaline sul and muriates: In the eaves'-droppings after a four hours' s nitrate of baryta alone acted, and caused merely a faint In eaves'-droppings after a twenty-four hours' shower, as in the snow-water from the country, none of the thre had any effect whatever.

Hence, perhaps even in a town, but at all events certai the country, it would be wrong to use for culinary purpos or snow-water which has run from lead roofs or spouts ly erected. When the roof or spout has been exposed fo time to the weather the danger is of course much lessened, entirely removed; because exposure to the weather enc with a firmly adhering coat of carbonate, through which, ready observed, even distilled water will not act. But lieve it would be right to condemn the turning even old l roofs to the purpose of collecting water for the kitchen. Alt the purest rain-water cannot act on them when it is onc at repose, we do not know what may be the effect of the tus of the falling rain on the crust of carbonate; and if the crust should happen to be thus worn considerably, or detached by more obvious accidents, the corrosion would then go on with rapidity as long as the shower lasted.

These remarks on the effect of rain-water on lead are pointedly illustrated by what *Tronchin* has recorded of the circumstances connected with the spreading of the lead colic at Amsterdam, about the time he wrote his valuable essay on that disease. Till that period lead colic was seldom met with in the Dutch capital. But soon after the citizens began to substitute lead for tiles on the roofs of their dwelling-houses, the disease broke out with violence and committed great ravages. Tronchin very properly ascribed its increase to lead entering the body insidiously along with the water, which for culinary purposes was chiefly collected from the roofs during rain. He farther attempts to account for the rain-water having acquired the power of corroding the lead, by supposing that it was rendered acid in consequence of the roofs having been covered with decaying leaves from the trees which abounded in the city; and without a doubt this explanation accords with the season at which the lead colic was observed to be most frequent,—namely, the autumn. But he does not seem to have been aware that rain-water itself possesses the corroding property, independently of any extrinsic ingredient except the gases it receives in its passage through the atmosphere *.

Mérat has referred to a Dutch author, Wanstroostwyk, for an account of a similar incident which happened at Haarlem †.

Spring-Water.—Most Spring-waters, unlike rain or snow-water, have little or no action on lead, because they generally contain a considerable proportion of muriates and sulphates.

As an example of a spring water which does not act on lead at all, the mineral water of Airthrey, near Stirling, may be mentioned. In four ounces of water from the strongest spring at Airthrey I kept for thirty-five days three bright rods of lead weighing 47.007 grains; and at the end of that period the rods were very nearly as brilliant as when they were first put in, and weighed 47.004 grains. This result is easily explained on considering the nature of the water: It contains no less than a seventy-seventh part of its weight of saline matters, which are chiefly sulphates and muriates.

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* *Tronchin* de Col. Pict. 66.—1757.

† De la Colique Métallique, 99, from *Wanstroostwyk* de l'Electric. Médicale, p. 224.

The water of Edinburgh is another example of spring water nearly destitute of action on lead. But it is not so completely inactive as the water of Airthrey. In four ounces of water three bright rods weighing fifty-seven grains lost in seven days a 250th of a grain, in twenty-one days a 100th, in thirty-five days a 66th, and in sixty-three days a 59th of a grain. In seven days the lead was hardly tarnished at all, and not a speck of powder could be seen in the water or on the glass. In twenty-one days, but still more in thirty-five or sixty-three days, the lead was uniformly dull; and on the surface of the water, as well as on the bottom of the glass, and on the side where left dry by the evaporation of the water, there were many white, filmy specks, which became black with the hydrosulphate of ammonia. In another experiment 145 grains of lead kept for six months in six ounces of Edinburgh water, which was filled up as it evaporated, lost a fifteenth of a grain; and the white encrustation on the bottom and sides of the glass gave a large proportion of black precipitate when scraped together and treated with hydrosulphate of ammonia. These experiments are of some practical importance. For they show that the impregnation which the water of Edinburgh can receive in a few days from being kept in lead is so small as to be barely perceptible by the nicest analysis; but that the impregnation may be material if the same portion of water is kept in lead for a considerable length of time. Hence the perfect safety of the leaden cisterns and service-pipes used in this city. The same portion of water rarely remains in them above a single day, and therefore cannot become impregnated in a degree that is appreciable by the nicest examination. *Dr Thomson* of Glasgow, in an interesting inquiry made in 1815 into the purity of the water which supplies Tunbridge, has stated that, when he lived in Edinburgh some years before, he could always detect a minute trace of lead suspended in the water, which at that time was brought six miles in leaden pipes *. I presume it is owing to the main pipes being now made of iron that this impregnation no longer exists. For I have found that the residue of two gallons of water, very carefully collected by gentle evaporation of successive portions in a small vessel, did not furnish the slightest trace of lead, when strongly heated with black flux and then acted on by nitric acid [*]. The feeble action of the Edinburgh water on lead arises from the salts it holds in solution. It contains about a 12,000th part of its weight of solid matter, of which about two-thirds are carbonate of lime, and one-third consists of the sulphates and muriates of soda, lime, and magnesia.

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* Appendix to *Dr Scudamore's* Analysis of the Mineral Water of Tunbridge, p. 51.

Of spring waters which act with inconvenient or dangerous rapidity on lead, several instances might be quoted. But it is hardly worth while mentioning more than one or two by way of illustration, because the nature of the waters has been very seldom described so carefully as to supply the means of explaining their operation.

A striking example was related some years ago by *Dr Wall* of Worcester. A family in that town, consisting of the parents and twenty-one children, were constantly liable to stomach and bowel complaints; and eight of the children and both parents died in consequence. Their house being sold after their death, the purchaser found it necessary to repair the pump; because the cylinder and cistern were riddled with holes and as thin as a sieve. The plumber who renewed it informed Dr Wall that he had repaired it several times before, and in particular had done so not four years before the former occupant died [†]. The nature of the water was not determined. Most of the water around Worcester is very hard; but this will not account for its operation in the instance now described. I presume it must have contained either an unusually small proportion of salts, or a large proportion of carbonic acid; or, which is perhaps fully more probable, the corrosion was the effect of some obscure galvanic action, of which I shall presently mention distinct examples [p. 494].

Another incident of the same kind, but hardly so unequivo-

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[*] Some effect may perhaps be also owing to a difference between the proportion of saline matter contained in the water of the Crawley spring, which has been introduced into the city since Dr Thomson resided here, and the proportion in the water with which the city was at that time supplied. I am not aware, however, of the difference between them, or that any material difference does exist.

[†] Trans. of London College of Physicians, ii. 400.

cal in its circumstances, was related in 1823 by *Dr*
Tunbridge. A plumber undertook to supply that tow
water for domestic purposes, and in 1814 laid a course
en pipes for a quarter of a mile. In the subsequent ye
cases of lead colic occurred among the inhabitants wh
supplied by those pipes; and one lady particularly, wh
great water-drinker, lost the use of her limbs for some
The inhabitants naturally became alarmed; iron pip
substituted; and no case of the colic appeared afterward
Brande analyzed the water which had passed through th
and detected lead in it, while at the same time none
detected at the source [*]. Some uncertainty is throw
these statements by the analytic researches of Drs Th
Scudamore, and Prout, and Mr Children. In sever
these gentlemen found that the Tunbridge water did
tain above a 600,000th part of lead,—a proportion wh
cording to the researches of Dr Thomson, no wat
where lead pipes are used,—and a proportion far too
to be the source of any injury to the human body [†].
sition to these ingenious views, however, and in suppo
statement of Dr Yeats, it may be replied that, pursua
experiments formerly detailed, water like that now in
can hardly fail to act powerfully on lead in favourable
stances; for according to the analysis of Dr Thomson
tremely pure, as it contains only a 38,000th part of sal
ter, three-fourths of which are a feebly protecting salt,
riate of soda [‡]. Hence if this water were kept for a
length of time in a leaden cistern, it would contract a st
pregnation of lead; and it might even become impregna
unsafe degree when simply transmitted through *new* lead

Since the last edition of this work was published, th
ing instructive illustration of the statement now
well as of some other views given above, has com
my own notice. A gentleman in Dumfries-shire res
bring to his house in leaden pipes the water of a fi
on his estate, from a distance of three quarters of

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[*] Hints on a mode of procuring Soft Water at Tunbridge—Journal xiv. 352.

[†] Scudamore's Pamphlet—Appendix—*passim*.

[‡] Ibidem, p. 47.

As I happened to visit him at the time, I took the opportunity of examining the action of a tumbler of the water on freshly burnished lead, and could not remark any perceptible effect in fourteen days. It appeared to me, therefore, that the water might be safely conveyed in lead pipes; and they were laid accordingly. No sooner, however, did the water come into use in the family, than it was observed to present a general white haze, and the glass decanters in daily use acquired a manifest white, pearly encrustation. On examining the cistern, the surface of the water, as well as that of the cistern itself, where in contact with it, was found completely white, as if coated with paint; and the water taken directly from the pipe, though transparent at first, became hazy and white when heated or left some hours exposed to the air. On afterwards analyzing the water direct from the spring, I found it of very unusual purity; as it contained scarcely a 22,000th of solid ingredients, which were sulphates, muriates, and carbonates. The reader can be at no loss to perceive why the experiment with a few sticks of lead in a tumbler was not a correct representation of what was subsequently to go on in the pipes: In fact, as the pipes were 4000 feet long, and three-fourths of an inch in diameter, each portion of water may be considered as passing successively over no less than 784 square feet of lead before being discharged. The remedy employed in this case will be mentioned presently, (p. 493.)

For other instances of the corrosive action of spring water on lead the reader may refer to Dr Lambe's treatise. Dr Lambe was led by his researches to imagine that no spring water whatever was destitute of this property in a dangerous degree. This wide conclusion is not supported by valid facts. Yet his work contains several accurate and instructive examples of the action in question. Thus among other instances he mentions that he had found the water of Warwick to act on lead with great rapidity, and once saw holes and furrows in a cistern there, which was the second that had been used in the course of ten years*. *Sir G. Baker*, in a letter to Dr Heberden, has related another striking instance of the same kind. Lord Ashburnham's house in Sussex was supplied from some distance with water, which was conveyed in leaden pipes. The servants being often affected with colic, which had even proved fatal to some of them, the water was carefully examined, and found to contain lea solvent power of the water was ascribed to its contai unusual quantity of carbonic acid gas [*]. This may be d

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* On Spring Waters, p. 14.

In the course of the preceding remarks allusion h made to the danger of keeping the same portion of w a length of time in leaden cisterns, if it has the power o on lead even in a trifling degree. The following illus deserve particular notice.

It was mentioned in p. 487 as the result of experim the small scale, that although the water of Edinburgh d contract a sensible impregnation of lead on remaining a f in contact with it, yet a sufficient action ensues in the co a few months to show that it might be dangerous to ke water long in a lead cistern. Since coming to this concl have had an opportunity of verifying it on a large scale. cistern in my laboratory in the University having late left undisturbed for four or five months with about six of water in it, I found so large a quantity of pearly crysta loose on the cistern and diffused through the water, th the whole was shaken up and transferred to a glass ve water appeared quite opaque.

Mérat observes that at the laboratory of the Medical of Paris there was procured by evaporating six loads, bably about 1000 pounds of water, which had been k months in a leaden pneumatic trough, no less than tw of finely crystallized carbonate of lead [†]. A fact of ev interest is mentioned in the Medical Commentaries. T of an East India packet, in consequence of being del contrary winds, were put on short allowance of wate men got their share each in a bottle; but the office their shares and kept it all in a lead cistern. In thre all the officers began to suffer from stomach and bow plaints, and for six weeks after had the lead colic; w men continued to enjoy good health. The surgeon lead in a tumbler of water without the process of conce by adding to it the sulphuret of potass [‡]. A similar acci been briefly alluded to by *Van Swieten*. He mentions, was acquainted with a family who were all attacked with colica pictonum in consequence of using for culinary purposes water collected in a large leaden cistern and kept there for a long time [*]. The composition of the water has not been mentioned in any of these instances; but the water of Paris is so strongly impregnated with calcareous salts that in ordinary circumstances its action on lead must be trifling.

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[*] *Lambe* on Spring Waters, 116.

[†] De la Colique Métallique, p. 98.

[‡] *Dr Duncan's* Medical Commentaries, xix. 313.

It was probably from confounding the consequences of keeping the same water long in a lead cistern with the action in ordinary circumstances, that Dr Lambe was led into the error of supposing that all spring waters whatever act on lead so powerfully, as to render it in his opinion advisable to abandon the use of this metal in the fabrication of pipes and cisterns. It must be admitted, however, that in all likelihood many waters will contain a trace of lead, without being kept more than the usual time in the pipe or cistern. For Dr Lambe's results correspond to a certain extent with the more recent and accurate researches of *Dr Thomson*, who mentions many instances where a faint trace of lead was found in the residue of the evaporation of a large quantity of spring water by himself, as well as by Dr Dalton, Dr Wollaston, and Mr Children [†]. But, as Dr Thomson properly adds, when the quantity does not exceed a 600,000th or a millionth part of the water, as in these instances, it is ridiculous to imagine that any harm can result to man from the constant use of it for domestic purposes.

Another fact of some practical consequence, which flows from the experimental conclusions stated above is, that although it may be perfectly safe to keep some waters in leaden cisterns, it may be very unsafe to construct the covers of this metal, because the water which condenses on the covers must be considered as pure as distilled water. It has been found that white lead forms in much larger quantity on the inside of the covers of cisterns than on the cisterns themselves, where both are constructed of lead. A remarkable illustration of this is mentioned in a paper read before the Academy of Sciences at Paris in 1788 by the *Comte de Milly*. About a year after getting two leaden cisterns erected in his house, to keep the water of the Seine for general domestic purposes, he was attacked with severe and obstinate colic; which led him to examine his He found that the sides, where they were occasionally posed by the subsidence of the water, and more espec leaden cover, were lined with a white liquid, which stantly dropping from the lid into the cistern, like the caverns where stalactites are formed. The water was sequence so strongly impregnated with lead as to giv precipitate with liver of sulphur *. The reason of thi rence is, that the water in the cistern is a solution of tative salts, but what reaches the lid is in a manner In Edinburgh the lids of the cisterns are invariably wood, whether on account of its superior cheapness m because a leaden cover had been found perishable, I been able to discover.

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[*] Comment. ad Boerhaav. § 1060, T. iii. 347. Edit. Lugd. Batav. 1753.

[†] Scudamore on the Analysis of Tunbridge Water, *Appendix*, 51, 53.

It may be well to conclude these remarks on the spring waters on lead with a general summary of the c cumstances to be adverted to in using lead for keeping veying water; to which may be added a few hints for ing action where it is found to have taken place.

The general results of the preceding inquiries are t or Snow-water for culinary use should not be collec leaden roofs, nor preserved nor conveyed in lead;—that rule applies to spring waters of unusual purity, wher ample the saline impregnation does not exceed a 15 the water;—that spring water, even though it contain proportion of salts, should never be kept for a long contact with lead;—and that cisterns should not be with lids of this metal.

Where action is observed to take place in the in particular waters it may in some cases be impossible to it by any attainable means. But the inquiries detail suggest two modes by which in other cases a complete may be found. It appears that, where a crust of car allowed to form slowly and quietly on the surface of l distilled water ceases to have any material action; and action is reduced almost to nothing if a crust be thu in a solution containing a minute quantity of some p protecting salt, such as phosphate of soda. It appea

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* *Rozier.* Observations sur la Physique, xiii. 145.

then that a remedy may be often found in the instance of unusually pure spring waters—either by leaving the new pipes filled with the water for a few months, care being taken not to draw any water from them in the interval,—or perhaps even more effectually by filling the pipes for a similar period with a solution containing about a 25,000th of phosphate of soda. I had determined to try the latter plan with the pipes in the Dumfries-shire case mentioned above, but recommended that in the first instance the pipes should be left for a few months full of the water of the spring, and the stopcocks kept carefully shut; and on this being done for three or four months it was found that the water afterwards passed with scarcely any impregnation of lead, and what little was contracted at first has since gradually diminished.

I should add that an effectual remedy has been lately introduced by a patent invention for covering lead pipes both externally and internally with a thin coating of tin.

In the remarks now made on the action of water on lead no account has been taken of the effect of the galvanic fluid in promoting it. This however is a most important co-operating agent, or rather perhaps it ought to be considered a distinct power; for it acts with energy where water alone acts least, namely when there is saline matter in solution, because then a galvanic current of greater force is excited. In general it is necessary that two different metals be present in the water before galvanic action be excited; but a very slight difference may be sufficient. For example it seems enough that the lead contain here and there impurities, constituting alloys slightly different from the general mass of the pipe or cistern. It is probable that galvanic action may be thus excited by the joinings being soldered with the usual mixture of lead and the more fusible metals; at least I have seen pipes deeply corroded externally, when made of sheets of lead rolled and soldered; and the action was deepest on each side of the solder, which had itself entirely escaped corrosion. Even inequalities in the composition of the lead may have the same effect. Sheet lead long exposed to air or water is sometimes observed to be corroded in particular spots; and these will always be found in the neighbourhood of parts of the metal differing in colour, hardness or texture from the general mass. I have not analyzed such spots conceive the supposition now made is exceedingly pr and supplies a ready explanation of the corrosion. Sin fects may arise simply from fragments of other metals lyi in contact with the lead.

I have no doubt that many of the instances of unusu pid corrosion of lead by water, such as that mentioned *Wall* [p. 488] are really owing, not to the simple actior ter, but to galvanic action excited obscurely in one or (the ways now mentioned.

Of the Action of Acidulous Fluids on Lead and its O:

Water which is acidulated with various acids acts with different degrees of rapidity.

We have seen that if it is acidulated with *Carbonic aci* act so energetically as in part to counteract the pres power of the neutral salts. The effect of *Sulphuric acid* is p Distilled water feebly acidulated with that acid acts m rapidly on lead than when quite pure. Thus I have fou if it contained a 4000th or even only a 7000th of sulphu fifty grains of lead kept in it for thirty-two days gain venth or twelfth of a grain in weight, and were cover beautiful crystals of sulphate of lead. A minute trace could be detected in the water. *Muriatic acid* is so more active as a solvent. Distilled water containing a of that acid acquired in thirty-two days a sweetish ta yielded by evaporation a considerable quantity of mu lead, while the lead rods lost weight, and were cover acicular crystals of the same salt.

It is much more important, however, to consider th of the vegetable acids on lead and its oxide, because tl vent power is a fruitful source of the accidental as we tentional adulteration of many articles of food and drin

Acetic acid in the form of common vinegar, even wh diluted, attacks and dissolves metallic lead, if, by expo surface of the fluid to the air, a constant supply of ox maintained to produce oxidation. The *Citric acid* wi it under the same circumstances, but acts more slowl solution of five grains of citric acid in twenty-four part drachms of water, three lead rods lost two grains in w nine weeks. The greater part of the citrate of lead separated slowly in white powdery crystals; but a small portion was dissolved by the excess of acid, and imparted to the fluid a pleasant sweetness. *Tartaric acid* acts much less energetically. In a comparative experiment with the last, the lead gained nearly half a grain in weight by acquiring a crystalline coat of tartrate of lead. But I could not detect any lead in solution; and there was no loose powder. The tartrate of lead is very sparingly soluble in an excess of its acid, so that a sweet taste cannot be so communicated to a fluid acidulated with tartaric acid.

The acids act with greater rapidity on the protoxide of lead than on the metal; and the presence of air is of course not required to enable them to effect its solution.

The solvent power of the acids is liable to be counteracted by various substances; but the operation of these substances has not been well ascertained. It appears, however, that substances containing gallic acid or tannin throw down the lead; and on this account various adulterations which would otherwise take place are either prevented or corrected. It has been also ascertained by *Proust*, that the vegetable acids do not attack lead when it is alloyed with tin. For as the latter metal has a stronger attraction than the former for the acids, no lead can be oxidated before the tin undergoes that change *.

From what has been said of the action of the vegetable acids, it follows that the preparation or preservation of articles of food and drink in leaden vessels is fraught with danger. For, if they contain a vegetable acid, more particularly the acetic, as many of them do, and if they are allowed to remain in the vessel for a moderate length of time, they will be apt to be impregnated with the metal. In this way lead has been often insidiously introduced into the food of man.

Thus milk has been poisoned by being kept in leaden troughs. An instance of the kind has been related by *Dr Darwin*. A farmer's daughter used to wipe the cream from the edge of the milk which was kept in leaden cisterns, and, being fond of cream, had a habit of licking it from her finger. She was seized in consequence with the symptoms of lead colic, afterwards with paralytic weakness of the hands, and she died of gen haustion [*].—The circumstances under which the lead i on have not been carefully examined. It appears to b times used with safety. If the milk should become sour in all probability be impregnated with the lead.

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* Ann. de Chim. lvii. 82.

Rum has been also supposed to be sometimes adu with lead by being allowed to come in contact with the The dry belly-ach of the West Indies, which appear the same disease with the lead colic, has been ascribed b practitioners to an adulteration of the kind. But on th ject precise information is still wanted. *Dr J. Hunter* h ed, in a paper published in the Transactions of the College of Physicians, that an epidemic colic, which a three of our regiments in Jamaica during the years 17 1782, and which seized almost every man of them, was by him to the presence of lead in the rum; and he end to show that the spirit might dissolve the lead in passing t the leaden worms of the distilling apparatus. [†] He another work, that, according to information communic Dr Franklin, the legislature of Massachussets passed a 1723, prohibiting the use of leaden still-heads and w the distillation of spirituous liquors [‡]. It is certain th has been often impregnated with lead; but it is by no clear that Dr Hunter has successfully accounted for th in which the adulteration is effected.

Wine has been accidentally impregnated in like man consequence of the bottles having been rinsed with sh some of the shot left behind. An interesting example has been related in the Philosophical Magazine. Sev dominal symptoms were caused by a bottle of wine; a cause was discovered to be the action of the wine on so in the bottom of the bottle. The shot had been so com dissolved, that it crumbled when squeezed between the fi The illness in this instance must have been owing to senic contained in the shot, because the quantity of le hardly sufficient to excite violent symptoms.—At o home-made British wines must have been frequently adulterated with lead, from the makers being ignorant of the dangerous nature of the adulteration. *Sir G. Baker* quotes the following receipt in a popular cookery book of his time: "*To Hinder wine from turning.*—Put a pound of melted lead in fair water into your cask, pretty warm, and stop it close [*]."

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[*] Zoonomia, ii. 130.

[†] Trans. of London College of Physicians, iii. 227.

[‡] On the Diseases of the Army in Jamaica, p. 269.

[§] Philosophical Magazine, liv. 229.

But by far the most remarkable adulteration of the kind now under review is that of cyder. At one time a disease in every respect the same as the lead colic used to prevail in some of the south-west counties of England at the cyder season; and it was generally ascribed, in consequenee apparently of the opinion of Huxham, to the working people indulging too freely in their favourite beverage during the season of plenty. The subject, however, was carefully investigated in 1767 by *Sir George Baker*, who succeeded in proving, that the disease arose from the cyder being impregnated with lead, sometimes designedly for the purpose of correcting its acescency when spoiled, but chiefly by accident, in consequence of the metal being used for various purposes in the construction of the cyder-house apparatus. The substance of his researches is,—that a disease in all respects the same with the lead colic was in his time so prevalent in Devonshire as to have supplied 289 cases to the Exeter Hospital in five years, and 80 to the Bath Infirmary in a single season, (1766); while, on the contrary, it was little, if at all, known in the adjoining counties of Gloucester, Worcester and Hereford, although cyder is there an equally common drink among all ranks:—that in the latter counties lead was seldom or never used in constructing the apparatus of the cyder-houses, while in Devonshire it was used sometimes for lining the presses, but more commonly for fastening the iron cramps, and filling up the stone joinings of the grinding troughs, and for conveying the liquor from vessel to vessel:—that lead does not exist in the cyder of Herefordshire, but may be detected both in the ripe cyder, and more especially in the must, of Devonshire:—that from eighteen bottles of cyder a year in bottle, 4½ grains of metallic lead were procured [†]. The accuracy of these facts, and the soundness of the conclusions which

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[*] Trans. of London College of Physicians, i. 216.

[†] On the Cause of the Endemial Colic of Devonshire. Transactions of the London Coll. of Phys. i. ii. and iii.

Sir George Baker drew from them have been unive mitted; and lead is now, I believe, completely exclu the cyder apparatus.

If lead is previously oxidated, the presence of acids in articles kept in contact with it is still more give rise to a poisonous impregnation, than in the cas itself.

Of accidental adulterations of this kind the most i is that which arises from the action of vegetable acid glazing of earthenware. This glazing is well known tc generally a considerable quantity of oxide of lead, and sequence is more or less easily dissolved by the vegetab A good example has been noticed by *Dr Beck* *. A fi Massachussets, consisting of eight persons, were all seiz spasmodic colic, obstinate costiveness, and vomiting; disease was satisfactorily traced to a store of stewed which had been kept some months in an earthenwar glazed with lead, and which had corroded the glazing. very interesting example has been lately described by *D baum* of Hildburghausen. A family of five persons violently affected for a long time with spasmodic colic, an with partial palsy. After examining many articles of fo Hohnbaum at last found that the vinegar for dressing th lads was kept in a large earthenware vessel capable of eight or ten quarts, and glazed with lead; that an ounce o gar remaining in the vessel contained no less than nine of lead; and that the whole glazing of the vessel was com dissolved †. Accidents like this appear from the statem the same author to have been common in Germany no ago. *Luzuriaga* attributes the great prevalence of c Madrid and the neighbourhood to the general use in t chen of earthenware glazed with lead ‡. *Jacob* impute the same cause §. But others have doubted the accuracy explanation.

The effect of acids on lead glazing appears to be va

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* Elements of Medical Jurisprudence, ii. 319.

† Zeitschrift für die Staatsarzneikunde, 1827, xiii. 151.

‡ *Mérat* de la Colique Métallique.

§ Diss. Inaug. sur la Colique de Madrid. Analyzed in *Corvisart's* J Médecine, xxxiv. 208.

Sometimes they hardly act on it at all [*]. The difference probably depends on differences in the composition of the glaze. *Gmelin* says, that if there is only a moderate proportion of oxide of lead in it, acids and fat do not corrode it; but that potters often use too much of the oxide, obviously to render the glaze more fusible; and that then it is easily corroded [†]. *Westrumb* states, that, if the lead glaze is thoroughly vitrified and not cracked, the strongest acids do not attack it [‡]. Farther experiments are still required to elucidate this subject.

It is not, however, by accident only that the food or drink of man is subject to be poisoned with lead. Many articles are adulterated with it designedly for a variety of purposes. These adulterations it is necessary for the medical jurist to study.

No kind of adulteration with lead is more common than that of wine; which, when it becomes acescent, or is originally too acid and harsh, may be materially improved in taste by the addition of litharge.

The practice of correcting unsound wines in this way seems to have been well known at an early period. Betwixt the years 1498 and 1577, various decrees were made against it by the German Emperors, and in some provinces the crime was even punished capitally [§]. For some time afterwards the dangerous effects of the practice appear to have been lost sight of in Germany. But towards the close of the seventeenth century, the attention of physicians and legislators in that country was pointedly directed to the subject by various writers in the *Acta Germanica* [‖]. The same practice has been long prevalent in France. The famous endemic colic of Poitou, which appeared in 1572, and raged for sixty or seventy years, has been with justice ascribed in modern times to the adulteration of wine with lead, and has given to the lead colic its scientific name *colica Pictonum*. More recently, the practice became exceedingly prevalent in Paris. About the year 1750, the farmers-general found that for some years before that, 30,000 hogsheads of sour wine were annually brought into Paris for the alleged purpose ing vinegar, while the previous yearly imports did not 1200. An inquiry was accordingly set on foot, whicl the discovery, that the vinegar merchants corrected tl wines with litharge, and thus made them marketable [*]. withstanding the active system of medical police in the capital, I believe the crime is not yet eradicated. Ind small tart wines used so abundantly there by all ranks, h great encouragement and facilities to its perpetration.

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[*] Hohnbaum, &c. p. 157.

[†] Geschichte der Mineralischen Gifte, 194.

[‡] Note in an Essay by his Son,—*Ueber Vergiftung durch Käse.* Horn's Archiv, 1828, i. 83.

[§] Gmelin's Geschichte der Mineralischen Gifte, 216.

[‖] *Cockelius*, Acta, &c. Dec. i. An. iv. Obs. 30. *Brunnerus*, *Ibidem*, Obs. 92. *Vicarius*, *Ibidem*, Obs. 100. *Riselius*, *Ibidem*, Dec. i. An. v. Obs. 251.

The process employed for correcting the acescency o is not precisely known. Some wines are easily correctec *rat* found that a bottle of harsh wine, which had a shar terish, rather acrid taste, took up in forty-eight hours grains of litharge, and became palatable [†]. With other this simple method will not answer, because the colour stroyed, and a taste is substituted which has no resembla that of the genuine wine. Thus *Orfila* remarked, that i gundy was neutralized with litharge, it acquired a sacc taste, and became pale-red, because the insoluble salts o which were formed, combined with and removed the colc matter [‡]. On the whole, it is probable that the adulterat wine with lead can only be practised with success on the mon tart kinds, such as those used by the lower orders c continent.

Some excellent observations have been published on thi ject by *Fourcroy*. In order to render what he has said i gible, it is necessary to premise, that, in the course of th mentation of wine, the supertartrate of potass, which accel the conversion of the sugar of the fruit into alcohol, is partly converted into malic acid; that in sound wine, there there is a mixture of tartaric and malic acids; but that i malic acid originally existed in the fruit in too great abund the fermentation of the sugar is imperfect, and the wine is sequently both too acid and too weak; and lastly, that all w if neglected, are apt to ferment too much, in consequen which they pass the vinous stage of fermentation, and be impregnated with acetic acid [§].

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[*] Paris and Fonblanque's Med. Jurisprudence, ii. 347.

[†] De la Colique Métallique, 212.

[‡] Toxicologie Générale, i. 616.

[§] Dr Macculloch on the Art of Wine-making, in Edin. Horticultural i. 134.

Now Fourcroy found that the oxide and other preparations of lead correct acescency and harshness in wines, not so much by throwing down the acids, as by combining with them in solution, and imparting to the liquor the peculiar sweetness of lead. Hence tart wines, which owe their acidity to too great a proportion of tartaric acid or supertartrate of potass cannot be improved by adulteration with oxide of lead. For the supertartrate of potass cannot act at all as a solvent on the oxides or carbonate of lead, and even pure tartaric acid takes up so little, that wine containing it could not acquire the sweet taste which is the object to be attained by the adulteration. This statement I have confirmed. But the case is very different when the wine contains acetic acid, the presence of which is the general cause of spoiling or acidity. For Fourcroy remarked, that acetic acid dissolves not only oxide and carbonate of lead, but likewise the tartrate, notwithstanding its great insolubility in water or in its own acid. Hence the presence of tartaric acid in a wine spoiled by the co-existence of the acetic, will not prevent the liquor from taking up oxide of lead in sufficient quantity to be sensibly improved in taste and flavour. Nay, an obvious mode of correcting excessive acidity, produced by too much tartaric acid, is to add acetic acid, and then to treat the mixture with oxide of lead. Fourcroy farther thinks, that the malic acid possesses the same solvent power as the acetic over the tartrate of lead, and that its presence may therefore be the reason why some acid wines, which do not contain the acetic acid, become nevertheless impregnated with the poison. The solvent power of acetic acid is increased by the presence of other vegetable principles in the wine *. I may add, that I have found the citric acid to possess the same property with the acetic and malic acids. It dissolves so much of the tartrate of lead as to acquire a very pleasant sweetness, quite unmixed with metallic astringency.

The practice of adulterating wine with lead does not seem to have been ever pursued to any material extent in Britain. Home-made wines have been adulterated in this way, as may be inferred from the receipt formerly quoted for preventing acescency. But I have never heard that any such adulteration has been suspected in the foreign wines usually drunk in this

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* Sur les Vins lithargyriés, Mém. de l'Académie, 1787, p. 280.

country. Considering, indeed, the nature of these w the class of people who alone make use of them, it is n that adulteration with lead could be practised with any If the foreign wines used in Britain should become e lead could hardly restore their taste so thoroughly as t on the consumer.

Sometimes spirituous liquors and preserves have be terated with lead, in consequence of sugar of lead havi used to clarify them, or to render them colourless. *Gassicourt* says it is a common practice in France to honey and sugar of grapes, and to make brandy pale way; and *M. Boudet* has detected lead in many san these articles as they are sold in Paris [*]. Hollands h wise been poisoned in the same manner. *Dr Shearma* tions his having detected an extensive adulteration of sm Geneva by an excise officer, which had been sold and di over an extensive tract of country, and which committe ravages among the inhabitants [†].

The adulterations hitherto noticed take place through of the chemical action of the adulterated substances on its oxide. Some other substances are occasionally contan with the metal by its compounds being merely mecha mixed with them. There is of course no end to the n and variety of adulterations of this kind. But the foll will serve as examples. *Gaubius* once detected an adult of butter with white lead at a time when it was very sca Flanders, owing to a dreadful mortality among the c An instance of poisoning with lead, in consequence of having been mixed with red lead, is mentioned in the Re ry of Arts [§]. This variety deserves to be remembered. lead was at one time a good deal used to communicate to the peculiar reddish-yellow colour, which is supposed characteristic of fineness of quality. In the Transacti the Medical Society of London, a singular instance has related by *Mr Deering*, of the lead colic attacking a wh mily, and proving fatal to two of them, in consequence of the insidious introduction of white lead into the body. Although the nature of the symptoms in the several cases left no doubt that lead was the cause of them, it was long before the source of it was discovered. Every vessel and article used in the kitchen was in vain examined; when at length it was discovered that the sugar used by the family had been taken from a barrel which had formerly contained white lead, and that, as the sugar from the centre of the barrel had been dug out, and given away to various friends, the outer part of it next the white lead was chiefly used by the family themselves *.

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[*] Journal Général de Médecine, xliv. 321.

[†] Edin. Medical and Surgical Journal, viii. 213.

[‡] Dehaen, Ratio medendi, P. x. c. viii. § 1.

[§] Repertory of Arts, First Series, viii. 262.

Process for detecting Lead in mixed Fluids.

The process for this purpose which has appeared to me the most convenient is a modification of one proposed by Orfila in the early editions of his Toxicology. In the first place, a little nitric acid should be added to the suspected matter before filtration; for nitric acid I find redissolves any insoluble compound formed by the salts of lead with albumen and other animal principles, as well as some of those formed with vegetable principles; and consequently renders it more probable, that the poison will be detected in the first part of the analysis, if present at all †. This being done, sulphuretted-hydrogen gas is to be transmitted through the fluid part of the mixture; and if a dark-coloured precipitate is formed, the whole is to be boiled and filtered to collect the precipitate.

In order to ascertain that the precipitate positively contains lead, those who are accustomed to use the blowpipe may put the sulphuret into a little hole in a bit of charcoal, and reduce it by the fine point of a blowpipe-flame, when a single globule is procured, which is easily distinguished by its lustre and softness. A better process, for those who are not accustomed to use the blowpipe, and perhaps a better test of the existence of lead in all circumstances, is to heat the sulphuret to redness in a tube, and to treat it with strong nitric acid, without heat or with the aid of a gentle heat only. The lead is thus dissolved

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* Trans. of London Medical Society, i., or Edin. Med. and Surg. Journal, viii. 211.

† The precipitate formed by acetate of lead with albumen is dissolved by nitric acid. From that formed with milk the acid removes the oxide of lead entirely, leaving the casein.

without the sulphur being acted on. The solution is th
diluted with water, filtered, evaporated to dryness, an
heated to expel the excess of nitric acid. If the residu
solved in water, it will present the usual characters o
solution when subjected to the proper liquid tests. C
the hydriodate of potass is to be preferred when the
is too small for trying more of them. But for this purp
must be taken to expel all the excess of nitric acid, bec
excess will strike a yellow colour with the test though
not present.

If the preceding process should not detect lead in th
ed part of the mixed fluid, then the insoluble matter left
filter is to be incinerated, and the residuum dissolved i
acid, and tested as the former. This branch, however,
very rarely required, if lead be present, because the pre
of adding nitric acid previous to filtration, dissolves t
from most of its compounds which are insoluble in water
process of incineration in medico-legal analysis generally
be avoided if possible, as it is not easily managed by unp
ed persons.—The present branch of the process of analy
be particularly required for the contents of the stomach
mited matter, when any sulphate or phosphate has been
as an antidote.

In the last edition of his Medecine-Légale [1832] Or
given a process differing little from that here detailed.

SECTION II.—*Of the Action of Lead and the Symptoms it in Man.*

The effects of the preparations of lead on the body ar
striking. They differ according to the rapidity with wh
enters the system. Large doses of its soluble salts cause
toms of irritant poisoning. The gradual introduction
of its oxidated preparations in minute quantities brings on
culiar and now well known variety of colic, which is oft
lowed by partial palsy, and in violent cases by apoplexy

The physiological effects and mode of action of the
salts in irritating doses have been examined experiment
Professor Orfila, *M. Gaspard*, *Dr Schloepfer*, and *Dr Ca*
Their experiments agree in showing that these poisons
direct irritating action, and a remote operation of an un

kind; but the results obtained by different experimentalists differ as to some of the details. The acetate may be taken as a type of the whole genus.

Orfila found that it was hardly possible to bring dogs under the action of the acetate if swallowed in solution, because they speedily discharged it all by vomiting. But if the salt was given in powder in the dose of half an ounce, or if the solution was retained in the stomach by a ligature on the gullet, the symptoms produced were those of violent irritation in the first instance, succeeded by extreme weakness and death, sometimes in nine hours, more generally not till the second day or later. The appearances in the body were unnatural whiteness of the villous coat when death was rapid, and vascular redness when death was slower. The whiteness in the former case Orfila ascribes to chemical action. But as neither this appearance nor the redness in the latter case was considerable, while at the same time the symptoms were not those of continuous irritation, he was led to doubt whether the poison causes death in consequence of its irritant properties. And the phenomena observed by him when acetate of lead was injected into the jugular vein prove that death is owing to certain remote effects. Introduced through this channel thirteen grains killed a dog almost immediately, death being preceded by no other symptom except convulsive respiration; five grains killed another in five days, and the leading symptoms were weariness, languor, staggering, and slight convulsions, none of which symptoms appeared till the third day; and it is remarkable that in neither animal could he find any morbid appearance on dissection *. I have found that a carefully prepared neutral nitrate of lead is powerfully irritant and corrosive in the dose of 400 grains. A large dog was killed in sixteen hours with violent diarrhœa and efforts to vomit, when this dose was administered in four ounces of water, and secured in the stomach by a ligature on the gullet. And after death the whole inner membrane of the gullet and stomach, and the villi of the upper half of the small intestines, were found uniformly white, brittle, and evidently disintegrated; and the mucous coat of the great intestines was bright red in parallel lines.

The experiments of *Gaspard* coincide with those of Orfila in assigning to the acetate of lead considerable activit it is directly introduced into the blood,—the quantity of four grains generally causing death in three or five The experiments of *Campbell* farther show that death induced by applying it to a wound, and that the sympt tecedent to death resemble those remarked by Orfila wh injected into a vein [†]. But the two last experimentali fer from Orfila in assigning to sugar of lead a property li possessed by arsenic, of acting on the alimentary cana when applied to a wound, or directly introduced into the For Campbell found the stomach corrugated and red, a small intestines also vascular; while Gaspard not only ob analogous appearances after death, but even also witnes the symptoms of violent dysentery during life.—In proof of the local irritating power of this poison, it may ded, that when sugar of lead was injected into the rectum bell found it to cause purging, tenesmus, itching of the and great debility.

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* Toxicologie Générale, i. 630.

The only inquiries I have hitherto met with, which as lead in continued small doses the power of producing i mals the peculiar colic and palsy so regularly produced b man are those of *Schloepfer*, related in his thesis on the of poisons when injected into the windpipe. He foun the acetate, introduced through this channel in successive of ten grains, brought on all the symptoms of *colica pict* preceded by oppressed breathing, and ending fatally with and convulsions in the course of three weeks [‡]. More re *Dr Wibmer*, in the course of some experiments on the continued use of acetate and carbonate of lead, which w mentioned presently, remarked weakness and stiffness o limbs in dogs; and in the rabbit I have observed in th circumstances gradually increasing weakness, ending in plete palsy of the fore-legs.

Lead has been sought for with variable success throu the fluids and solids of men and animals who had died of were at the time labouring under its effects. *Gmelin*, w quoting his authority for the fact, observes that it may

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[*] Journal de Physiologie, i. 284.

[†] Diss. Inaug. p. 27.

[‡] De Effectibus liquidorum in vias aeriferas, &c. p. 43.

tected in the bodies of persons afflicted with colica pictonum [*]. In recent times, *Schloepfer* analyzed the flesh, liver, lungs, intestines, and blood of a rabbit killed in three weeks by the disease, without being able to detect any trace of the metal [†]. And *Barruel* and *Mérat* were not more successful in their attempts to discover it in the urine and fæces of their patients, though they used the precaution of operating on large quantities [‡]. Very different results, however, have been obtained more lately by *Dr Wibmer*, a German physiologist. He poisoned two dogs,—one with sugar of lead given in small doses daily to the amount of two drachms and eight grains in the course of thirty-seven days,—the other with white lead given to the extent of two drachms in fourteen days,—at the end of which periods the animals died. In both there was frequent vomiting and gradually-increasing weakness and stiffness of the legs. In the dead body the only unusual appearance was an overflow of dark greenish-yellow bile, which distended the gall-bladder, and lined the whole stomach and intestines. Various fluids and several of the soft solids were carefully examined for lead; and Dr Wibmer succeeded in discovering it distinctly in the liver and the muscles, but especially in the spinal chord; while a mere trace only could be found in the blood, and none at all in the bile, urine, or brain. The process of analysis consisted simply in deflagrating the matter for examination with nitre, acting on the residue with nitric acid, filtering and neutralizing the solution, and testing it with sulphuretted-hydrogen, carbonate of potass, and hydriodate of potass [§]. These remarkable experiments are supposed by the author to account for the palsy and convulsions induced by lead, as well as for the wasting of the muscles; since they seem to prove that the poison is concentrated by some vital operation on the muscular system and spinal chord.—I have repeated Dr Wibmer's researches, but not with similar results. In one rabbit, killed in the course of an hour or more by a drachm of acetate of lead, not a particle of lead could be found in the spinal chord; but in the solution procured by Wibmer's process from the lumbar and dorsal muscles it was indicated distinctly by sulphuretted-hydrogen, less distinctly by chron potass, and still less so by hydriodate of potass. To ar rabbit eight grains of sugar of lead were given daily fo days, and on the ninth day sixteen grains killed it in h hour,—the symptoms being extreme flaccidity, weaknes torpor, without coma. The spinal chord, the brain, the h and crural muscles, and the liver, were separately examin lead, but no trace of it could be found except in the h muscles, where it was faintly indicated by sulphuretted-h gen.—All of these experiments, as well as the original i tigations of Dr Wibmer, are exposed to a probable sour fallacy, which at the time they were made was not suspect exist,—the presence of traces of copper in the animal solid fluids, (See p. 430.) I have already said that I doubt th curacy of the experiments which led *M. Sarzeau* to ann the presence of copper in all animal solids and fluids; an reason is, that in many of the experiments which have just shortly described neither Dr Wibmer nor myself remarke indication of copper. If M. Sarzeau's discovery, howeve admitted, the results described above as pointing out the sence of lead in certain parts of animals poisoned with it ar conclusive, because copper would give the appearances pr ced by the most characteristic tests, sulphuretted-hydroge chromate of potass.

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[*] Geschichte der Mineralischen Gifte, 118.

[†] De Effectibus liquidorum, &c. 44.

[‡] Traité de la Colique Métallique, 120.

[§] Tract. de Effectu Plumbi in organismo animali sano, necnon de Therapia intoxicationis saturnina. Autore Carol. Wibmer. Monachii, 1829, p. 29.

It is probable that all the preparations of lead are poiso except the metal, and perhaps also the sulphuret. The ex mentalists at the Veterinary School of Lyons found that n four ounces of the metal might be given to a dog without vomiting being excited; and Orfila remarked that an oun carefully prepared sulphuret had as little effect [*]. It is pr ble that irritant poisoning can be produced only by those pounds which are soluble, such as the acetate, subacetate, nitrate. It appears indeed from the experiments of Orfila the acetate and my own with the nitrate, that these compo are true corrosives, and of no mean energy when given in l doses moderately diluted.

The insoluble compounds, such as the carbonate, red and protoxide, possess little irritant power. The experim ists of Lyons found litharge to be irritant in large doses o an ounce [*]. But Orfila gave dogs large doses of the red oxide and carbonate without observing any signs of irritation in the stomach; and a case has been published of a young woman having swallowed accidentally an ounce and a-half of the carbonate without any bad effect whatever either at the time or afterwards[†].

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[*] Arch. Gén. de Médecine, xix. 328.

It may be presumed that all the compounds of lead which are soluble in water or in the animal fluids may produce in favourable circumstances the lead colic and palsy. Dr A. T. Thomson, indeed [‡], has endeavoured to show by some experiments that the carbonate is the only compound of lead which possesses this singular power, and that if the acetate of lead produces similar effects, it is only because that salt usually contains an excess of oxide which becomes carbonate from the action of free carbonic acid in the stomach and other parts of animals, or because the salt is decomposed by double decomposition from the accidental presence of alkaline carbonates. It does not appear to me, however, that the researches of Dr Thomson, taken along with the prior inquiries of other physiologists, will bear out this conclusion. The experiments of Wibmer in particular would seem to show that the carbonate is at least not more active than the acetate; nor does it appear probable that the small doses of acetate given by him, seldom exceeding two or three grains at a time, could yield any carbonate in the alimentary canal of a dog, where there is commonly much free muriatic and acetic acid. Farther, in many of the instances of lead colic related above as produced by cyder, wine, and other acid substances acting on lead or its oxide, the acid must have been so greatly in excess that it was scarcely possible that carbonate of lead could have been formed afterwards by any ordinary accident. And even supposing the carbonate to be more active than other compounds in occasioning colic and palsy, as Dr Thomson's inquiries would tend to show, the fact may be admitted without necessarily leading to the inference that it is the only active compound of lead, or that other preparations must be converted into the carbonate before they can act as slow poisons. For the superior activity of the carbonate may be owing to the great obstinacy with which its impalpable powder adheres to moist membranous surfaces, and the consequent greater certainty of its ultimate absorption. It certainly appears a but consistent with a general law, to which hitherto no un ed exception has been found, that the carbonate must be d ed before it can act constitutionally.

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[*] Corvisart's Journal de Médecine.

[†] *Krüger* in *Rust's* Magazin für die gesammte Heilkunde, xi. 535.

[‡] London Medical Gazette, v. 538.

The Symptoms observed in Man from the preparati lead are of three kinds. One class of symptoms indicate i mation of the alimentary canal: another spasm of its mu and a third injury of the nervous system, sometimes apo more commonly palsy, and that almost always partial a complete. Each of these classes of symptoms may exist pendently of the other two; but the last two are more com ly combined.

The irritant effects of large doses of the soluble salts o come first under consideration. Of these the acetate, or of lead may be taken as an example.

Here it will in the first instance be observed that, acco to the experiments mentioned above, the acetate of lead, th certainly an irritant poison, is not very energetic,—being less so than the vulgar generally believe, and far inferi most of the metallic poisons hitherto treated of. This fa appears from the experience of physicians as to its effec medicinal doses. The acetate has been often given in p large doses in medical practice; and although it has some excited colic when continued too long, ordinary irritation stomach seems to have been rarely observed. *Mr Dani* a late paper on its effects as a remedy for mercurial saliva states that he gives it in doses of ten grains three times a and that he never observed it excite any other unpleasant s tom except slight colic, which seldom came on till after the fo dose *. I have often given it in divided doses to the amou eighteen grains daily for eight or ten days, without remar any unpleasant symptom whatever, except once or twice s colic. *Van Swieten* even mentions a case in which it was to the amount of a drachm daily for ten days before it any material symptom †.

Yet facts are not wanting to prove that acetate of lead improper dose will produce violent and immediate effects. symptoms are then either those of simple irritation, or more monly those of inflammation united with the peculiar spasmodic colic of lead, and sometimes followed by convulsions and coma, or by local palsy.

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* London Med. Repos. N. S. vi. 368.

† Comment. 1060, T. iii. p. 347. Editio Dan Barbari.

In one of *Sir George Baker's* essays there is an instance of immediate and violent symptoms having been caused by a drachm taken twice with a short interval between the doses. The subject was a soldier who took it in milk to cure a diarrhœa. Five hours after the first dose he was seized with pain in the bowels and a feeling of distension round the navel. After the second these symptoms became much more acute; and he was soon after seized with bilious vomiting, loss of speech, delirium, and profuse sweating, while the pulse fell down to 40. He recovered, however, with the aid of diluents and cathartics *.

A case which proved rapidly fatal has been related in a French journal. A drummer in a French regiment, who was much given to drinking, stole some Goulard's extract, and drank it for wine. Neither the first symptoms nor the dose could be ascertained. On the second day he was affected with loss of appetite, paleness, costiveness, and excessive debility; on the third day he had severe and excessive colic, drawing in of the belly, loss of voice, cold sweats, locked jaw, and violent convulsions; and he expired before the evening of the same day. The morbid appearances will be mentioned in their proper place. Sugar of lead was detected in the stomach †.

In both these instances the disorder excited partook very much of the character of the spasmodic colic which is caused by the gradual introduction of lead into the body; and in the last the whole course of the man's illness was very like that of the worst or most acute form of *colica pictonum*. But in another example which came under my own notice the symptoms were more nearly those of ordinary irritation,—namely, vomiting, burning, and pricking pain in the throat, gullet, and stomach, with trifling colic subsequently; but the patient recovered in two or three days. The quantity taken was supposed to exceed a quarter of an ounce.

In another instance related by *Mr Iliff* of London, where an ounce of the salt was accidentally swallowed in solution, the symptoms were at first colic pains and vomiting, in the course of a few hours vomiting and tenderness, and, after these symptoms receded, a peculiar state of rigidity and numbness, which

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* Trans. Coll. Phys. London, iii. 426.

† Journal Universel, xx, 351.

was not entirely removed for several days. In this cas
medies were used for three hours; and even two hou
when the stomach-pump was resorted to on account
slightness of the vomiting, lead was found in the fir
withdrawn,—a new proof of the feeble action of acetate
compared with some other metallic poisons[*].

So much for the operation of the acetate of lead i
doses. Physicians, however, are much better acquaint
the effects of lead when introduced into the body conti
and insidiously in minute quantities. For all tradesm
work much with its preparations are apt to suffer in th
and many other persons have been brought under its ac
consequence of articles of food and drink being impre
with it. The disease which is thus induced may be
into two distinct stages.

The first stage is an affection of the alimentary ca
leading feature of which is violent and obstinate colic.
symptom at times begins abruptly during a state of sound
but much more commonly it is ushered in by a derange
of the stomach, not unlike common dyspepsia, seldom so
as to cause alarm, and almost always imputed at first to a
cause. By and bye the uneasiness, which was confined
stomach, stretches throughout the whole abdomen.
same time the stomach becomes irritable, and the food
jected by vomiting. Cramps in the pit of the stomac
succeed, and ere long they extend to the rest of the bel
at length the complete colic paroxysm is formed. The
sometimes pretty constant; sometimes it ceases at interv
together; but much more commonly there are remissions
than intermissions; and it is remarked that both the rem
and exacerbations are much longer than those of commo
The pain is very generally, yet not invariably, relieved b
sure; even strong pressure very seldom causes any unea
provided it be not made on the epigastrium; nay, some p
have been known to bear, with relief to the paroxysm
weight of two or of three people standing on the belly[†].
belly is almost always hard, the abdominal muscles bein
tracted: Sometimes it is rather full, more commonly t

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[*] London Medical Repository, 1824, N. S. iii. 37.

[†] Mérat de la Colique Métallique, 51.

verse, and the navel is often drawn in so as almost to touch the spine. The bowels all the while are obstinately costive. Either there is no discharge from them at all, or scanty, knotty fæces are passed with much straining and pain. In a few instances diarrhœa takes the place of the opposite affection. The urine is commonly diminished, but the saliva increased in quantity and bluish in colour. From the beginning, or more generally after a few hours or days, the limbs are racked with cutting pains. The aspect of the countenance is dull, anxious, and gloomy: In advanced cases the expression of gloomy anxiety exceeds that of almost all other diseases. It appears from the latest works on this disease published in France, and particularly from the able treatise of Mérat, that the pulse is rarely accelerated, but on the contrary is often retarded *. This does not accord with the experience of some earlier writers †; and I may add, that in the few cases, which this city has afforded me opportunities of witnessing, fever has been always present, and that in one patient the pulse was 100, very full and hard. It cannot be questioned, however, that, as Mérat states, fever is not essential. The skin has a dull, dirty, cadaverous appearance, is often, though not always hot, and in either case is bedewed with irregular, clammy, cold perspiration.

This, the first stage of colica pictonum, may end in three ways. In the first place, the patient may recover at once from it as from an ordinary colic; and it is consolatory to know, that a first attack, taken under timely management, is for the most part easily made to terminate in that favourable manner. In such circumstances it rarely endures beyond eight days. But it is exceedingly apt to recur, if, for example, the patient expose himself to what in ordinary circumstances would cause merely a common colic or diarrhœa; and if he returns to a trade which exposes him again to the poison of lead, the disease is sure to recur sooner or later, and repeatedly, unless he observes the greatest precautions. In one or other of these returns, sometimes even in the first attack, the colic is not succeeded by complete recovery, but gives place to another more obstinate and more alarming disease. This secondary affection is of two sorts.

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* Mérat de la Colique Métallique, p. 55.

† Tronchin de Colica Pictonum. Geneva, 1757.

One, which occurs chiefly in fatal cases, is a species of a
The other, which does not of itself prove fatal, is parti

In violent and neglected cases of colica pictonum, t
becomes attended in a few days with giddiness, great
and torpor; as the torpor advances the pains in the b
limbs abate; at length the patient becomes convulsed
matose, from which state very few recover. A very r
mination allied to that now described is sudden death
the colic stage, without any symptom which would l
to suspect its approach. A case of this kind has been
by *M. Louis*. His patient, five minutes after talking
attendant of his ward, was found at his bedside in the ag
death; and no cause for so sudden a death could be fo
dissection *.

In cases, on the other hand, which have not been neg
and particularly when the attack is not the first, the dep
of the colic often leaves the patient in a state of extreme
lity, which by and bye is found to be a true partial palsy,
or less complete. This affection is sometimes present l
the colic departs, but is apt to escape notice till the pain a
The palsy is of a peculiar kind. It affects chiefly the
extremities, and is attended with excessive muscular emaci
The loss of power and substance is most remarkable in the
cles which supply the thumb and fingers; and in ever
which I have seen the extensors suffered more than the fl
The paralysis is hardly ever complete, except perhaps i
extensors of the fingers. When it is considerable, the po
of the hands is almost characteristic of the disease. The l
are constantly bent, except when the arms hang straight
by the side; they dangle loose when the patient moves; he
not extend them, and raises one arm with the aid of the o
When in this state he usually complains also of racking
in the limbs and arms, his digestion is feeble, and trivial c
renew the colic. From this deplorable condition it is still
sible to restore him to health, chiefly by rigorous attention t
gimen. But he too often dies in consequence of a fresh a
of colic as soon as he returns to his fatal trade.

The lead palsy, however, does not always come on i
regular manner. Sometimes the primary stage of colic is

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* *Louis*, Recherches Pathologiques, 483.

ing, so that the wasting of the muscles and loss of power are the first symptoms. I have seen a characteristic example of the kind in a sailor who had been employed for a month in painting a vessel. He had great weakness and wasting of the arms and hands, particularly of the ball of the thumb; but except a tendency to indigestion, costiveness, and transient slight pain of the belly, he had suffered no previous disorder of the intestines. *Dr Bright* mentions similar effects occurring in the instance of a painter who in seven years had three attacks of the same kind, not preceded by colic [*].

Colica pictonum is the only disease which has been distinctly traced to the operation of lead insidiously introduced into the body. But many other disorders have been ascribed to its agency. *Boerhaave* seems to have imagined that consumption might be so induced; and *Dr Lambe* thought that to this cause may be traced the increased prevalence of "scrofula, phthisis, dropsy, chronic rheumatism, stomach complaints, hypochondriasis, and the host of nervous complaints which infest modern life [†]." These conjectures are wholly destitute of foundation in fact.

In whatever form lead is habitually applied to the body, it is apt to bring on the train of symptoms mentioned above;—the inhalation of its fumes, the habitual contact of any of its compounds with the skin, the prolonged use of them internally as medicines, or externally as unguents and lotions, and the accidental introduction of them for a length of time with the food may sooner or later equally induce colica pictonum.

Instances have occurred of colic produced by the prolonged use of sugar of lead inwardly as a drug [‡]. Different practitioners, however, have obtained different results as to the facility with which it operates. The causes of the difference have not been particularly investigated; but it is probable that a larger quantity, or more prolonged employment of it, is required to produce manifest effects than has been tried by those who deny its tendency to occasion colic.—With regard to the lead colic being excited by the application of unguents and lotions to the external surface of the body, *Sir George Baker* mentions a case that occurred under his own notice of violent col rently brought on by litharge ointment applied to the va adds that children have been thrown into convulsion same substance sprinkled on sores; and he quotes Zell case where symptoms of poisoning were occasioned by ling the axilla with it, as a cure for redness of the face *Wall*, in a letter to the preceding author, mentions his seen the bowels affected by Goulard's extract applied to and in another paper he has given two unequivocal cases of which colic was brought on by saturnine lotions app a pustular disease, and in the other by immersing the leg a-day for ten days in a bath of the solution of acetate of Such accidents, however, are exceedingly rare, and som liary cause must have favoured the operation of the po the cases now noticed; for every one knows that free made of lead unguents and lotions, yet we seldom hear bad consequences.—These cases, however, will probal move the doubts which some entertain of the possibility colic being induced by the application of the compounds to the sound skin in those trades which compel the wo to be constantly handling them. At the same time it m admitted, that in all these trades there exists a more obvio ready channel for the introduction of the poison; becau workmen are either exposed to breathe its fumes, or are transfer its particles from the fingers into the stomach with food.—Of all exposures none is more rapid and certai breathing the vapours or dust of the preparations of lead. for that very reason workmen who are so exposed seldo fer; because the greatness of the risk has led to the diso of means to avert it, and the openness of the danger rend easy for the workmen to apply them.

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[*] Reports of Medical Cases, ii. 394.

[†] *Lambe* on Spring Waters, p. 71.

[‡] *Sir George Baker*, in Trans. of Coll. Phys. i. 236, 301, 304.

To these observations on the various ways in which le sidiously enters the system a few remarks may be added o trades which expose workmen to its influence. The mo curate information on this subject is contained in the wo Mérat.

He places foremost in the list miners of lead. In this try miners are now rarely affected, because the freque colica pictonum among them formerly led their masters to

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[*] Trans. of Lond. Coll. Phys. i. 311. [†] Ibid. iii. 435.

the subject, and to employ proper precautions for removing the danger. It has been stated by *Dr Percival*, and is generally thought, that the whole workmen in lead mines are apt to be attacked with the colic,—those who dig the sulphuret as well as those who roast the ore[*]. If this idea were correct it would be in contradiction with the general principle in toxicology, that the metals are not poisonous unless oxidated. But the opinion is in all probability founded on error; for, according to information communicated to me by *Mr Braid*, who was some years surgeon at Leadhills in Lanarkshire, the workmen who dig and pulverize the ore there, although liable to various diseases connected with their profession, and particularly to pectoral complaints, never have lead colic till they also work at the smelting furnaces.

Next to miners may be ranked manufacturers of litharge, red-lead and white-lead. The workmen at these manufactories are exposed to inhale the fumes from the furnaces or the dust from the pulverizing-mills. It has been chiefly among the workmen of a former white-lead manufactory in the neighbourhood of Edinburgh that I have had an opportunity of witnessing the lead colic. By a simple change the proprietor made in the process, and which will be mentioned presently, the disease was almost extirpated some years before the manufactory was given up.

Next in order, perhaps in the same class with colour-makers, are house-painters. The cause of their liability is the great quantity of the preparations of lead contained in the paints they use. It would appear that lead colic is most frequent among people of that trade in cities of the largest size. In Geneva, as I am informed by my friend *Dr C. Coindet* of that place, colica pictonum is now almost unknown and never occurs among painters. In Edinburgh it is also little known among painters. A journeyman painter, a patient of mine in the Infirmary, had been seventeen years in the trade, and yet did not know what the painters' colic or lead palsy meant. In London, according to the Dispensary reports, and in Paris, according to the tables of Mérat, many workmen of that trade suffer. I have been informed by an intelligent workman, once a patient of mine, who had been a journeyman painter both in London and Edinburgh, that the number of his acquaintances who had been with the colic in the metropolis was incomparably grea here. This man ascribed the difference to the workin being more in the former place, so that the men had no enough to make it worth their while to clean themselv fully in the intervals. This appears a rational explana do not know how the great prevalence of colic among in Paris is to be accounted for.

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[*] On the Poison of Lead, p. 22.

Plumbers, sheet-lead manufacturers, and lead-pipe- are also for obvious reasons apt to suffer; but as they necessarily exposed to the vapours of lead, and suffer consequence of handling it in the metallic form, it ougl an easy matter to protect them. They themselves c that a very hazardous part of their occupation is the re the melted lead from the melting pot to make the sh pipes; but this operation is not dangerous if the melti are properly constructed.

A few cases of lead colic occur among glass-blowe ziers, and potters, who use the oxide of lead in their res manufactures. There are a few also among lapidari others, who use it for grinding and polishing stones or and among grocers and colourmen who sell its various rations. Printers are rarely attacked with the colic, b are generally considered to be subject to partial palsy hands, which is ascribed to the frequent handling of the I have met with one case apparently of this nature.

Lead is not the only metal to which the power of in colica pictonum has been ascribed. *Mérat* has mentio veral instances of the disease occurring among brass-fo and other artizans who work with copper[*]. *Tronchin* Scheuchzer for a set of well-marked cases which happen convent of monks, and where the malady was supposed t been traced to all the utensils for preparing and keepin food having been made of untinned copper[†]. The sa thor mentions two cases, one of which came under his diate notice, where the apparent cause was the long-co use of antimonial preparations internally[‡]. *Mérat* has li found a few iron-smiths and white-iron-smiths in the li a waiter, and an attorney's clerk.—Age or youth seem afford any protection against the poison. Of the 279 c were under 20, and among these were several painter-b above fifteen years old; 113 were between nineteen and 66 between twenty-nine and forty; 38 between thirty-n fifty; 28 between forty-nine and sixty; and 10 older tha These proportions will correspond pretty nearly with lative number of workmen of similar ages.—Among t cases fifteen died, or 5.4 per cent.

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[*] De la Colique Metallique. [†] De Colica Pictonum, p. 56. [‡] Il

SECTION III.—*Of the Morbid Apppearances caused by*

The morbid appearances caused by poisoning with l in some respects peculiar.

The only opportunity, so far as I know, which has h occurred of inspecting the body of a person killed rap the irritant action of lead, was in the case of the drumm merly quoted, [p. 512.] The lower end of the gullet, the stomach and duodenum, a part of the jejunum, and the a ing and transverse colon were greatly inflamed; and the coat of the stomach appeared as if it had been macerated stomach contained six ounces of a reddish-brown fluid whi a sweetish, styptic, metallic taste, exhaled the odour of v while evaporating, and yielded globules of lead when t residue was subjected to the process of reduction *. T tection of lead in the stomach after the patient survived three days is an important fact in medico-legal chemistr

According to *Professor Orfila*, when the quantity of the of lead has been large, the stomach in animals, instead of red, has sometimes a peculiar blanched appearance, aris he supposes, from chemical action †. The blood of animals to be sometimes altered in nature. *Dr Campbell* once fo fluid. In a dog poisoned with litharge, the experimental the Veterinary School at Lyons found it of a vermilion in the veins, and brighter than usual in the arteries ‡.

The appearances found in the bodies of those who ha of the various forms of lead colic are different, and who connected with inflammation.

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* Journal Universel, xx. 353.

† Toxicologie Générale, i. 637.

‡ Corvisart's Journ. de Médecine.

The valuable work of *Mérat* contains four inspections after death from the acute or comatose form of colica pictonum. The bodies were plump, muscular, and fat. The alimentary canal was quite empty, and the colon much contracted,—in one to an extraordinary degree. The mucous coat of the alimentary canal was every where healthy. He therefore infers that the disease is an affection of the muscular coat only. It is a striking circumstance, and conformable with what will be afterwards established in regard to the true narcotics, that, although both of the men died convulsed and comatose, no morbid appearance was visible within the head *. Another case, which confirms the foregoing facts, has been described by *Mr Deering*. It was that of a lady who died convulsed after suffering in the usual manner, and in whose body no trace of disease could be detected any where †. *Senac* informed Tronchin that he had dissected above fifty cases of colica pictonum and found no morbid appearances ‡. *Schloepfer's* observations on animals are to the same effect. In the rabbits which died of colica pictonum the great intestines were excessively contracted, but all the other organs of the body were healthy except the liver, which was dark and brittle §. The only instance I have met with where morbid appearances were found within the head, was in a case mentioned by Sir G. Baker of a gentleman who died apoplectic after many attacks of colica pictonum, and in whom the brain was found unusually soft, and blood extravasated on its surface to the amount of an ounce ||.

The appearances in those who have been long affected with the paralytic form of colica pictonum have been rarely observed in modern times. I am indebted to my late colleague, *Dr Duncan, Junior*, for the only good account I have been able to procure of the inspection of the intestinal canal in such a case. The man, who was a plumber, had been long and frequently afflicted with colica pictonum and its sequelæ. The intestines were dark, tender, and far advanced in putrefaction. The cardiac orifice of the stomach was so narrow that it would only admit a

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* De la Colique Métallique, p. 213.

† Trans. of the Lond. Med. Society, 1810, or Edin. Med. and Surg. Journal, viii. 211.

‡ *Tronchin* de Colica Pict. p. 117.

§ De effectibus liquidorum ad vias aërif. applic. p. 43.

|| Trans. of Lond. Coll. of Physicians, i. 469.

goose-quill. The mesenteric glands were enlarged a dened. The thoracic duct was surrounded by many la dies, like diseased glands, exactly of the colour of le composed of organized cysts containing apparently an in matter. The analysis of this matter was unfortunately n ed. The muscles in similar circumstances are much di When the paralysis is not of long standing, it appears fr experiments of Schloepfer, (whose animals survived abou weeks,) that the whole muscular system becomes pale, less, and flaccid. When the palsy is of long standin change increases so much, that the muscles in some pa in the arms and thumbs, acquire the colour and general of white fibrous tissue. Some observations on the nat these changes will be found in the essays of Sir G. Ba The facts are communicated by *Mr John Hunter.* Or mining the muscles of the arm and hand of a house-p who was killed by an accident, Mr Hunter found them a cream colour, and very opaque, their fibres distinct, an texture unusually dry and tough. These alterations he a imagined might have been the result merely of the pals consequent inactivity of the muscles; but he changed hi nion on finding the same alterations produced by the dire tion of sugar of lead on the muscles of animals; and he red that the poison gradually effected a change either o muscles directly, or on the blood which supplied them. hardly necessary to observe, that whatever truth there m in his conclusions, the reason assigned for them will not the inference he has drawn; for the acetate of lead, whe plied directly to a muscle, effects a chemical change, in c quence of which the animal matter unites with the oxi lead,—an action which we have no reason to suppose o in the muscles during the course of the painter's palsy.

SECTION IV.—*Of the Treatment of Poisoning with Lea*

The treatment of poisoning with lead, and the mode of tecting workmen from its influence, will now require a fe marks.

For the irritant form of poisoning, a safe and effectual dote exists in any of the soluble alkaline or earthy sulpl If none of these be at hand, then the alkaline carbonates

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[*] Trans. of Lond. Coll. Phys. i. 317.

be given, particularly the bicarbonates, which are not so irritating as the carbonates. The phosphate of soda is also an excellent antidote. If the patient does not vomit, it will be right also to give an emetic of the sulphate of zinc. In other respects, the treatment does not differ from that of poisoning with the irritants generally.

Colica pictonum is usually treated in this country with great success by a practice much followed here in colic and diarrhœa of all kinds,—the conjunction of purgatives with anodynes. A full dose of a neutral laxative salt is given, and an hour afterwards a full dose of opium. Sometimes alvine discharges take place before the opium acts, more commonly not till its action is past, and occasionally not for a considerable time afterwards. But the pain and vomiting subside, the restlessness and irritability pass away, and the bowels return nearly or entirely to their natural condition. Sometimes it is necessary to repeat the practice. It is almost always successful: I have seldom seen the second dose fail to remove the colic, leaving the bowels at worst in a state of constipation. When the pulse is full and strong, I have seen venesection premised with apparent advantage; in some instances it appeared to me to be called for by the flushing of the face and the violence of the spasms; and I have never seen it otherwise than a safe remedy, notwithstanding the fears expressed by *Dr Warren* and others *.

The hospital of La Charité in Paris has long enjoyed a high reputation for the treatment of this disease. The physician commences with what is called the painter's purge, which is a decoction of half an ounce of senna in a pound of water, mixed with half an ounce of sulphate of magnesia and four ounces of the wine of antimony. Next day an ounce of sulphate of magnesia and three grains of tartar emetic are administered in two pounds of infusion of cassia, to keep up the operation of the first laxative. In the evening a clyster is given, containing twelve ounces of wine and half as much oil. After this the patient is made to vomit with tartar emetic, then drenched with *ptisanes* for several days, and the whole is wound up with another dose of the painter's purge succeeded by gentle anodynes. I am not aware of any particular advantage possessed by this complicated and tormenting method of cure, which is not equally possessed by the simpler plan pursued in Britain.

* Trans. of Lond. Coll. Phys. ii. 83.

Among the many other methods of cure that have bee
posed for the primary stage of this disease salivation b
cury deserves to be particularized. It appears to hav
often used with success, the colic yielding as soon as th
lism begins *. If the case, however, is severe, there is n
to lose in waiting for the action of the mercury to com

The treatment in the advanced period of the disease,
the palsy is the chief symptom remaining, depends alm
tirely on regimen. The patient must for a time at lea
altogether his unlucky trade. He should be allowed th
generous food he can digest. He ought to take frequent
exercise in the open air, but never to fatigue. The ha
ing the most severely injured of the affected parts, and
same time the most important to the workman, the practit
attention should be directed peculiarly to the restorat
their muscular power. This appears to be most easily b
about by frictions, electricity, and regulated exercise, the
being also supported in the intervals by splints extendin
the elbows to the fingers. The dragging of the em
muscles by the weight of the dangling hands certainly se
retard their recovery.

When a person has been once attacked with colica pic
he is more easily attacked again. Hence if he is young e
he should, if possible, change his profession for one in w
is not brought into proximity with lead. Few, howeve
it in their power to do so. The prophylaxis, therefo
mode of preventing the influence of the poison becomes
ject of great importance; and more particularly when w
sider the vast number of workmen in different trades
safety it is calculated to secure.

On this subject many useful instructions are laid d
the work of *Mérat*. He very properly sets out with in
on the utmost regard being paid to cleanliness,—a poi
much neglected by most artizans, and neglected particul
those to whom it is most necessary, the artizans who wor
the metals. In proof of the importance of this rule he o
he knew a potter who contracted the lead colic early
when he was accustomed to go about very dirty, but for

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* *Clark*, in Edin. Med. Comment. xi. 102. *Berger* in Horn's Ar
Mediz. Erfahrung, xi. 344. Lond. Med. and Phys. Journ. xxvi. 46.

years after had not any return of it, in consequence simply of a scrupulous attention to cleanliness. In order to secure a due degree of cleanliness three points should be attended to. In the first place, the face and hands should be washed once a-day at least, the mouth well rinsed, and the hair occasionally combed. Secondly, frequent bathing is of great consequence both with a view to cleanliness and as a general tonic; so that masters should make it an object to provide their workmen with sufficient means and opportunities for practising it. Lastly, the working clothes should be made, not of woollen, but of strong, compact linen, should be changed and washed at least once and still better twice a-week, and should be worn as little as possible out of the workshop. While at work a cap of some light impervious material should always be worn.

Next to cleanliness the most important article of the general prophylaxis relates to the means to be employed for preventing the food of the workmen from being impregnated with lead. For this end it is essential that they never take their meals in the workshop, and that before eating they wash the lips and hands with soap and water, and brush out all particles of dirt which may have lodged under the nails. It is also of some moment that they breakfast before going to work in the morning.

Derangements of the digestive organs should be watched with great care. If they appear to arise from the poison of lead, the individual should leave off work with the very first symptom, and should take a laxative. Habitual constipation should be provided against.

The nature of the diet of the workmen is of some consequence. It should be as far as possible of a nutritive and digestible kind. *Mérat* condemns in strong terms the small tart wines generally used by the lower ranks of his countrymen. They constitute a very poor drink for all artizans; and are peculiarly ill adapted for those who work with lead, because, besides being at times themselves adulterated with that poison, they are also apt to disorder the bowels by their acidity. Beer is infinitely to be preferred. Various articles of diet have been recommended as tending to impede the operation of the poison. *Hoffmann* recommends brandy, the efficacy of which few workmen will dispute. There is some reason for believing that the free use of fat and fatty articles of food is a preservative. *De-*

haën was informed by the proprietor and the physician of
mine in Styria, that the work-people were once very lia
colic and palsy, but that, after they were told by a quack
to eat a good deal of fat, especially at breakfast, they we
empt from these diseases for three years *. Another fact
kind was communicated to *Sir George Baker* by a physic
Osterhoüt, near Breda. The village used to be the resi
of a great number of potters, among whom he did not w
a single case of lead colic in the course of fifteen years;
attributes their immunity to their having lived much on c
butter, bacon, and other fatty kinds of food †. *Mr Wils*
in his account of the colic at Leadhills in Lanarkshire, th
glish workmen, who live much on fat meat, suffer les
Scotchmen, who do not ‡.

Some have likewise proposed as an additional preser
that the exposed parts of the body should be anointed wit
or fatty matters. But *Mérat* maintains with some reaso
the lead will be thereby enabled to penetrate the cuticle
easily by friction and pressure.

The observance of the preceding rules will depend of
in a great measure on the intelligence and docility of the
men, directed by the vigilance and authority of their m
Some other objects also of much consequence are to be
ed by the humanity and skill of the masters only.

The workshop should be spacious, and both thorough
systematically ventilated, the external air being freely ad
when the weather will allow, and particular currents bei
tablished, by which floating particles are carried throu
workshop in certain invariable and known courses. M
and others who work at furnaces in which lead is smelted,
or oxidated, should be protected by a strong draught th
the furnaces. According to Mr Braid, wherever furna
such a construction were built at Leadhills, the colic disa
ed, while it continued to recur where the furnaces were
old, low-chimneyed form. Manufacturers of litharge an
lead used formerly to suffer much in consequence of th
naces being so constructed as to compel them to inhale t

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* Ratio Medendi, P. I. c. ix. de Variis.

† Trans. of London Coll. of Phys. ii. 457.

‡ Ed. Phys. and Lit. Ess. i. 521.

dust of the oxides. In drawing the furnaces the hot material is raked out upon the floor, which is two or three feet below the aperture in the furnace; and the finer particles are therefore driven up and diffused through the apartment. But this obvious danger is now completely averted by a subsidiary chimney which rises in front of the drawing aperture, and through which a strong current of air is attracted from the apartment, the hot material on the ground performing the part of a fire.

In white-lead manufactories a very important and simple improvement has been effected of late in some places by abandoning the practice of dry-grinding. In all manufactories of the kind, the ultimate pulverizing of the white lead has been long performed under water. But in general the preparatory process of rolling, by which the carbonate is separated from the sheets of lead on which it is formed, continues to be executed dry. This is a very dangerous operation, because the workmen must inhale a great deal of the fine dust of the carbonate. In a white-lead manufactory which formerly existed at Portobello, the process was entirely performed under water or with damping; and to this precaution in a great measure, was imputed the improvement effected by the proprietor in the health of the workmen, and their superior immunity from disease over those of Hull and other places, where I am informed the same precaution is not taken. The only operation latterly considered dangerous at the Portobello works was the emptying of the drying stove, and the packing of the white lead in barrels; and the dust diffused in that process was kept down as much as possible by the floor being maintained constantly damp. By these precautions, and by care being taken to make the workmen wash their hands and faces before leaving the works for their meals, and to administer a brisk dose of castor oil on the first appearance of any complaint of the stomach or bowels, the manufacturer succeeded in extirpating the colica pictonum entirely for several years.

CHAPTER XIX.

OF POISONING WITH BARYTA.

Baryta and its salts, the last genus of the metallic irri which requires particular notice, are commonly arranged an earthy substances, but on account of their chemical and] siological properties, may be correctly considered in the sent place. These poisons are worthy of notice, because are not only very energetic, but likewise easily procure that they may be more extensively used, when more gene known.

Section I.—*Of the Chemical Tests for the preparations of Ba*

Three compounds of this substance may be mentioned, pure earth or oxide, the muriate or hydrochlorate, and the bonate. The pure earth, however, is so little seen, that unnecessary to describe its chemical or physiological proper

The *Carbonate of Baryta* is met with in two states. So times it is native, and then commonly occurs in radiated stalline masses, of different degrees of coarseness of fibre, n ly colourless, very heavy, and effervescing with diluted mu tic acid. It is also sold in the shops in the form of a fine p der of a white colour, prepared artificially by precipitatin soluble salt of baryta with an alkaline carbonate. It is known by its colour, insolubility in water, solubility with fervescence in muriatic acid, and the properties of the result muriate of bartya.

The *Muriate*, or *Hydrochlorate*, is the most common of compounds of this earth, having been for some time use medicine for scrofulous and other constitutional disorders. is procured either by evaporating the solution of the carbon in hydrochloric acid, or by decomposing a more common mi ral the sulphate, by means of charcoal aided by heat, dissolv in boiling water the sulphuret so formed, and decomposing sulphuret by hydrochloric acid.

It is commonly met with in the shops irregularly crystalli in tables. It has an acrid, irritating taste, is permanent in the air, and dissolves in two parts and a half of temperate water.

The solution is distinguished from other substances by the following chemical characters. From all other metallic poisons hitherto mentioned, it is easily distinguished by means of sulphuretted-hydrogen, which does not cause any change in barytic solutions. From the alkaline and magnesian salts it is distinguished by the effects of the alkaline sulphates, which do not act on the former, but cause in all solutions of baryta a heavy white precipitate, which is insoluble in nitric acid. From the hydrochlorates of lime and strontia, it is to be distinguished by evaporating the solution till it crystallizes. The crystals are known not to be hydrochlorate of lime, because they are not deliquescent. The hydrochlorate of strontia, (which resembles that of baryta in many properties, but which must be carefully distinguished as it is not poisonous,) differs in the form of the crystals, which are delicate six-sided prisms, while those of the barytic salt are four-sided tables, often truncated on two opposite angles, sometimes on all four,—by its solubility in alcohol, which does not take up the hydrochlorate of baryta,—and by its effect on the flame of alcohol, which it colours rose-red, while the barytic salts colour it yellow. The hydrochlorate of baryta is known from the other soluble barytic salts, by the action of nitrate of silver, which throws down a white precipitate.

Vegetable and animal fluids do not decompose the solution of the hydrochlorate of baryta, except by reason of the sulphates and carbonates which most of them contain in small quantities. But the action of its tests may be disguised, although the salt has not undergone decomposition. In that case the most convenient method of analysis is to add a little nitric acid, which will dissolve any carbonate of baryta that may have been formed,—to filter and then throw down the whole baryta in the form of sulphate, by means of the sulphate of soda,—and to collect the precipitate, and calcine it with charcoal for half an hour in a platinum spoon or earthen crucible, according to the quantity. A sulphuret of baryta will thus be procured, which is to be dissolved out by boiling water, and decomposed after filtration by muriatic acid. A pure solution is thus easily procured.

SECTION II.—*Of the Action of the Salts of Baryta, and*
Symptoms they excite in Man.

The action of the Barytic salts on the body is energ
Like most metallic poisons, they seem to possess a twofol
tion,—one local and irritating, the other remote and indic
by narcotic symptoms. This narcotic action is more dec
and invariable than in the instance of any of the metallic
sons hitherto noticed. Such at least is the result of the e
riments of *Mr Brodie* [*], which have since been amply conf
ed by *Professor Orfila* [†] and *Professor Gmelin* [‡]. Orfila fc
that when the hydrochlorate was injected into the veins
dog in the dose of five grains only, death ensued in six min
and was preceded by convulsions, at first partial, but afterw
affecting the whole body. Mr Brodie found the same ef
follow in twenty minutes, when ten grains were applied
wound in the back of a rabbit,—the convulsions being prec
by palsy, and ending in coma. Half an ounce when inje
into the stomach excited the same symptoms in a cat, and p
ed fatal in sixty-five minutes, though the animal vomi
Schloepfer observed, that when a scruple, dissolved in
drachms of water, was injected into the windpipe of a rat
it fell down immediately, threw back its head, was convul
in the fore-legs, and died in twelve minutes [§]. Gmelin obs
ed in his experiments that it caused slight inflammation of
stomach, and strong symptoms of an action on the brain, sp
and voluntary muscles. He found the voluntary muscles
titute of contractility immediately after death; yet the h
continued to contract vigorously for some time, even without
application of any stimulus. From some experiments mad
horses by *Huzard* and *Biron*, by order of the Société de S
of Paris, it appears that the hydrochlorate, when given to th
animals in the dose of two drachms daily, produced sud
death about the fifteenth day, without previous symptom
any consequence [‖]. In the experiments now related, very li
appearance of inflammation was found in the parts to which
poison was directly applied.

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[*] Philosophical Transactions, 1812, p. 218.

[†] Toxicologie Générale, i. 208.

[‡] Versuche über die Wirkungen, &c.

[§] Diss. Inaug. de effectibus liquidorum ad vias aërif. applic. p. 30.

[‖] Nicholson's Journal, First Series, i. 529.

The pure earth appears to produce nearly the same effects in an inferior dose. When swallowed, the symptoms of local irritation are more violent; but death ensues in a very short space of time, and is preceded by convulsions and insensibility. The stomach after death is found of a reddish black colour, and frequently with spots of extravasated blood in its villous coat.

The carbonate in a state of minute division is scarcely less active than the hydrochlorate, since it is dissolved by the acid juices of the stomach. A drachm killed a dog in six hours; vomiting, expressions of pain, and an approach to insensibility preceded death; and marks of inflammation were found in the stomach [*]. *Pelletier* made many experiments on the poisonous properties of the carbonate. Fifteen grains of the native carbonate killed one dog in eight hours, and another in fifteen [†]. *Dr Campbell* found it to be a dangerous poison, even when applied externally. Twelve grains introduced into a wound in the neck of a cat, excited on the third day languor, slow respiration and feeble pulse; towards evening the animal became affected with convulsions of the hind-legs and with dilated pupils; and death followed not long afterwards [‡]. This substance, before its real nature was known, used at one time to be employed in some parts of England as a variety of arsenic for poisoning rats.

The symptoms produced by the salts of baryta in man have seldom been particularly described. An instance is shortly noticed in the Journal of Science, where an ounce of the hydrochlorate was taken by mistake for Glauber's salt, and proved fatal. The patient immediately after swallowing it felt a sense of burning in the stomach; vomiting, convulsions, headach, and deafness ensued; and death took place within an hour [§].

Dr Wilson of London has lately described a distinct case of poisoning with the carbonate. The quantity taken was half a tea-cupful; but emetics were given, and operated before any symptoms showed themselves. In two hours the patient complained of dimness of sight, double vision, headach, tinnitus, and a sense of distension in the stomach, and subsequen pains in the knees and cramps of the legs, with occasion miting and purging next day; for some days afterward head symptoms continued, though more mildly, and sh much subject to severe palpitations; but she was in the w recovery when the account of her case was published [*].

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[*] *Orfila*, Toxicol. Gén. i. 213.

[†] Observations sur la Strontiane. Ann. de Chimie, xxi. 119.

[‡] Diss. Inaug. de venenis Mineralibus, p. 31.

[§] Journal of Science, iv. 382.

Unpleasant effects have been observed from too large of the muriate administered medicinally. A case is menti in the Medical Commentaries of a gentleman who was dir to take sixteen drops of a solution as a stomachic, but swall one evening by accident seventy or eighty drops. He had after profuse purging without tormina, then vomiting, and an hour after swallowing the salt excessive muscular debi amounting to absolute paraplegia of the limbs. This state ed about twenty-four hours, and then gradually went off [†]. have known violent vomiting, gripes, and diarrhœa prod in like manner by a quantity not much exceeding the usual dicinal doses. *Mr Parkes* mentions that, according to info tion communicated to him by the proprietor of an estate in I cashire, where the carbonate of baryta abounds, many dom animals on his estate died in consequence of licking the du the carbonate, and that it once proved fatal to two perso woman and her child, who took each about a drachm [‡]. *Johnstone* says he once swallowed ten grains of this compo without experiencing any bad effect [§].

SECTION III.—*Of the Morbid Appearances caused by th Salts of Baryta.*

No account has yet been published of the morbid appeara as they occur in man. In animals the mucous membrane of stomach is usually found of a deep-red colour, unless death t place with great rapidity, in which case the alimentary can healthy. In all the animals, which in Dr Campbell's exp ments were killed by the application of the muriate to wou the brain and its membranes were much injected with blo and in one of them the appearances were precisely those of c gestive apoplexy.

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[*] London Medical Gazette, xiv. 487.

[†] Medical Commentaries, xix. 267.

[‡] Parkes's Chemical Essays, ii. 219.

[§] Essay on Poisons, p. 143.

SECTION IV.—*Of the Treatment.*

The treatment of this variety of poisoning consists chiefly in the speedy administration of some alkaline or earthy sulphate, such as the sulphate of soda or sulphate of magnesia. The poison is thus immediately converted into the insoluble sulphate of baryta, which is quite inert. *Orfila* has related a very interesting experiment by which the virtue of the sulphates as antidotes is completely established. Two drachms of muriate of baryta were injected into the stomach of a dog, and in eight minutes two drachms of sulphate of soda were also introduced. The gullet was then secured by a ligature. At first efforts were made to vomit, and in an hour sulphate of baryta was discharged with the alvine evacuations. There was neither insensibility nor convulsions; and next morning the animal evidently suffered only from the ligature on the gullet. This fact not only proves the efficacy of the sulphate, but likewise shows that in the kinds of poisoning where diarrhœa occurs, the poison is very soon discharged, and ought therefore to be looked for in the evacuations from the bowels *.

A few observations will be here required on the effects of the salts of *Strontia* on the animal frame. These compounds bear a close resemblance to the salts of baryta, and the two earths were consequently long confounded together till *Dr Hope* pointed out the difference between them. One of the most striking differences is, that the salts of Strontia are very feebly poisonous. Some experiments of this purport were made by *M. Pelletier* of Paris †, and by *Blumenbach*; but the most accurate researches are those more lately conducted by *Professor Gmelin.* He found that ten grains of the muriate in solution had no effect when injected into the jugular vein of a dog,—that two drachms had no effect when introduced into the stomach of a rabbit,—that half an ounce was required to cause death in that way,—that two drachms of the carbonate had no effect,—and that two drachms of the nitrate, dissolved in six parts of water and given to a rabbit, merely caused increase of the frequency and hardness of the pulse and a brisk diarrhœa ‡.

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* Toxicologie Générale, i. 216.

† Observations sur la Strontiane, Annales de Chimie, xxi. 119.

‡ Versuche über die Wirkungen, &c.

VEGETABLE ACRIDS.

THE Fourth order of the Irritant Poisons contains a number of genera derived from the vegetable kingdom formerly arranged in a class by themselves under the ti Acrid Poisons. The order includes many plants of the ral families *Ranunculaceæ*, *Cucurbitaceæ*, and *Euphorbiaceæ* other plants scattered throughout the botanical system likewise comprehends a second groupe consisting of some poisons from the animal kingdom, namely, Cantharides, sonous Fishes, Poisonous Serpents, and animal matters be poisonous by Disease or Putrefaction.

CHAPTER XX.

OF POISONING WITH THE VEGETABLE ACRIDS.

THE Vegetable Acrids are the most characteristic poiso this Order. They will not require many details, as the seldom resorted to for criminal purposes, and their mode tion, their symptoms, and their morbid appearances are n the same in all.

We are chiefly indebted to *Professor Orfila* for our k ledge of their *Mode of Action*. He has subjected them t sets of experiments. In the first place, he introduced the son in various doses into the stomach, sometimes tying the let, sometimes not: and, secondly, he applied the poison t subcutaneous cellular tissue by thrusting it into a recent w

In the former way he found that, unless the gullet was the animal soon discharged the poison by vomiting and rally recovered; but that, if the gullet was tied, death be caused in no long time by moderate doses. The sym were seldom remarkable. Commonly efforts were made t mit; frequently diarrhœa followed; then languor and lis ness; sometimes, though not always, expressions of pain; rarely convulsions; and death generally took place durin first day, often within three, six, or eight hours. The ap ances in the dead body were redness over the whole m coat of the stomach, at times remarkably vivid, often b perceptible, and occasionally attended with ulcers; very often a similar state of the whole intestines, more especially of the rectum; and in some instances a slight increase of density, with diminished crepitation, in patches of the lungs.

When the poison, on the other hand, was applied to a recent wound of the leg, the animal commonly whined more or less; great languor soon followed; and death took place on the first or second day, without convulsions or any other symptom of note. It was rarely that any morbid appearance could then be discovered in the bowels. But in every instance active inflammation was found in the wound, extending to the limb above it and even upwards on the trunk. Every part affected was gorged with blood and serum; and an eschar was never formed. The appearances in short were precisely those of Diffuse Inflammation of the cellular tissue, when it proves fatal in its early stage *.

Since these poisons do not appear to act more energetically through a wound than through the stomach, it has been generally inferred that they do not enter the blood, and consequently that the local impression they produce is conveyed to distant organs through the nerves. This inference is correct in regard to such species of the vegetable acrids as act in small doses. But the validity of the conclusion may be questioned when the poison acts only in large doses, as is the case with many of the poisons now under consideration. For they cannot be applied to a wound over a surface equal to that of the stomach, and may therefore be more slowly absorbed in the former than in the latter situation. And, in point of fact, a few plants of the present order have been found to act through the medium of absorption, as soon as chemistry discovered their active principles, and thus enabled the physiologist to get rid of fallacy by using the poison in small doses. This principle has been proved to be in some plants a peculiar resin, in others a peculiar fecula or extractive matter, in others an oil, in others an alkaloid, and in others a neutral crystalline matter. But in all there exists some principle or other in which are concentrated the poisonous properties of the plant. Some of these principles appear to act through the medium of the blood.

There is no doubt, however, but many plants of the present

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* *Toxicol. Gén.* i. *passim.*

order, as well as their active principles, have a totally difl and very peculiar action. They produce violent spreadii flammation of the subcutaneous cellular tissue, and acute ii mation of the stomach and intestines without entering the l and death is the consequence of a sympathy of remote c with the parts directly injured.

As to their forming a natural order of poisons, it is ev that if a general view be taken of their properties, they ai tinguished by obvious phenomena from the three orders h to noticed. But if their effects on man be alone taken in count, when of course their influence on the external surl the body must be left out of view, nothing will be disco to distinguish them from several of the metallic irritants.

The *Symptoms* occasioned in man by the irritant pois the vegetable kingdom, are chiefly those indicating inflamn of the villous coat of the stomach and intestines. When in large doses, they excite vomiting soon after they are lowed; by which means the patient's life is often saved. sometimes, like the mineral poisons that possess emetic pı ties, the vegetable acrids present a singular uncertainty i respect: They may be retained without much inconvei for some length of time. If this should happen, or if th be less, in which case vomiting may not be produced at if only part of a large dose be discharged at an early peri vomiting,—the other phenomena they give rise to are som fully developed. The most conspicuous symptom then is rhœa, more or less profuse. The diarrhœa and vomitii commonly attended by twisting pain of the belly, at first tent, but becoming gradually more constant, as the infl tion is more and more strongly marked. Tension, fulne tenderness of the belly, are then not unfrequent. The may assume all the characters of the discharges in natu flammation of the intestinal mucous membrane; but an tional character worthy of notice is the appearance of frag of leaves or flowers belonging to the plant which has been lowed. At the same time there is generally excessive ness. Sometimes, too, giddiness and a tendency to deliriur been observed. But the latter symptoms are rare: If th curred frequently, it would be necessary to transfer any poison which produced them to the class of narcotico-acrids.

The properties now mentioned have long ago attracted the attention of physicians, and led them to introduce the vegetable irritants into the Materia Medica. In fact they comprehend a great number of the most active, or, as they are technically called, Drastic purgatives. Among others, elaterium, euphorbium, gamboge, colocynth, scammony, croton, jalap, savin, stavesacre, are of this description. The effect of most of them, however, is so violent and capricious, that few are now much used except when combined with other milder and more certain laxatives.

The *Morbid Appearances* they leave in the dead body are the same with those noticed under the head of their mode of action,—more or less redness of the stomach, ulceration of its villous coat, redness of the intestines, and especially of the rectum and colon, which are often inflamed when the small intestines are not visibly affected.

In the following account of the particular poisons of this order, a very cursory view will be taken of their physical and chemical properties. A knowledge of these properties will be best acquired from any author on the Materia Medica; and an account of them would be misplaced in a work which professes to describe only the leading objects of the medical jurist's attention.

A great number of genera might be arranged under the present head. But the following list comprehends all which require mention. *Euphorbia*, or Spurge, the *Ricinus*, or Castor-oil-tree, the *Jatropha*, or Cassada plant, Croton-oil, *Elaterium*, or Spurting-cucumber, *Colocynth*, or Bitter-apple, *Bryony*, or Wild-cucumber, *Ranunculus*, or Butter-cup, *Anemone*, *Stavesacre*, *Celandine*, *Marsh-Marigold*, *Mezereon*, *Spurge-laurel*, *Savine*, *Daffodil*, *Jalap*, *Manchineel*, *Cuckow-pint*.

The first plants to be noticed belong to the natural order *Euphorbiaceæ*, namely the Euphorbia, Ricinus, Jatropha, and Croton.

Of Poisoning with Euphorbium.

Euphorbium is the inspissated juice of various plants of the genus Euphorbia or spurge, but is principally procurec the *E. officinarum*, a species that abounds at the Cape of Hope. It contains a variety of principles; but its chief dient is a resin, in which its active properties reside. been analyzed by *Braconnot*, *Pelletier*, *Brandes*[*], and *Drs ner* and *Herberger*. According to Brandes, the resin forms 44 per cent. of the crude drug, and is so very acrid, tl eyelid is inflamed by rubbing it with the finger which has ed the resin, even although it be subsequently washed v alkali[†]. According to the most recent analysis, that (Buchner and Herberger, this resin is a compound sub which consists of two resinous principles, one possessing i degree the properties of an acid, and the other the pro of a base. The latter, which they have called Euphor considered by them the true active principle of Euphorl It will be mentioned under the head of Jalap, that the taken the same view of the nature of other resinous poi

Orfila found that a large dog was killed in twenty-si and a-half by half an ounce of powder of euphorbium ir ced into the stomach, and retained there by a ligature gullet. The whole coats of the stomach, but especially t lous membrane, were of a deep-red, or almost black colo colon, and still more the rectum, were of a lively-red in ly, and their inner membrane was checkered with little —Two drachms of the powder thrust into a wound in the and secured by covering it with the flaps of the incision a dog in twenty-seven hours; and death was preceded by markable symptom except great languor. The wounde was found after death highly inflamed, and the redness a guinolent infiltration, which were alluded to in the gene servations on the vegetable acrids, extended from the l high up the trunk as the fifth rib,—a striking proof of pidity with which this variety of inflammation diffuses

The most common symptoms occasioned in man by e bium are violent griping and purging, and excessive exha but it appears probable that narcotic symptoms are also a induced. A case of irritant poisoning with it has been related in the Philosophical Transactions; but it is not a pure one, as a large quantity of camphor was taken at the same time. Much irritation was produced in the alimentary canal; but by the prompt excitement of vomiting and the subsequent use of opium the patient soon recovered [*]. A fatal case has been related by *Mr Furnival* in Mr Brand's Journal. A farrier gave a man a teaspoonful by mistake for rhubarb. Burning heat in the throat and then in the stomach, vomiting, irregular hurried pulse, and cold perspiration were the leading symptoms; and the person died in three days. Several gangrenous spots were found in the stomach, and its coats tore with the slightest touch [†]. The operation of this substance is so violent and uncertain, that it has long ceased to be employed in the regular practice of medicine, and has been even excluded from most modern Pharmacopœias. I understand it is still sometimes used by farriers as an external application; and in the Infirmary of this city I met with a fatal case of poisoning in the human subject, which was supposed to have been produced by a mixture containing it, and intended to cure horses of the grease. *Pyl* has related the proceedings in a prosecution against a man for putting powder of Euphorbium into his maid-servant's bed; and from this narrative it appears, that, when applied to the sound skin, it causes violent heat, itching and smarting, succeeded by inflammation and blisters [‡].

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[*] Supplement to Dr Duncan's Dispensatory, p. 53.

[†] *Buchner's* Repertorium für die Pharmacie, vi. 175.

[‡] Ibidem, xxxvii. 203.

[§] *Toxicol. Gén.* i. 710.

Probably all the species of Euphorbium possess the same properties as the *E. officinarum*. *Orfila* found that the juice of the leaves of the *E. cyparissias* and *lathyris* produces precisely the effects described above. *Sproegel* applied the juice of the latter to his face, and was attacked in consequence with an eruption like nettle-rash; and he found that it caused warts and hair to drop out [§]. *Vicat* mentions analogous facts, and *Lamotte* notices the case of a patient who died in consequence of a clyster having been prepared with this species instead of the mercurialis [||]. The seeds and root of the *E. lathyris* or caper-spurge are used by the inhabitants of the northern Alps in the dose of fifteen grains as an emetic; and very lately the the seeds has been employed in Italy as an active purg which in the dose of two or eight grains is said to poss the efficacy of croton oil [*]. *MM. Chevallier* and *Aubergie* also found the seeds of the *E. hyberna*, and their express to be very energetic. The seeds yield 44 per cent. of oil, in the dose of ten drops produces copious watery evacu without pain, and resembles closely croton-oil in its eff The *E. esula* appears to be a very active species. *Scopo* i that a woman who took thirty grains of the root died i an hour, and that he once knew it cause fatal gangrene imprudently applied to the skin of the belly [‡]. *Witheri* serves that all the indigenous species blister and ulcerate th and that many of them are used by the country people for purposes [§].

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[*] Phil. Trans. 1760, li. 662.

[†] Journal of Science, iii. 51.

[‡] *Aufsätze und Beobachtungen*, i. 79.

[§] *Toxicol. Gén.* i. 712.

[||] Ibidem, i. 713.

I have nowhere seen any notice taken by authors of na symptoms as the effect of poisoning with euphorbium; a deed this substance has always been considered a pure ir I am informed, however, by the Messrs Herring, wh druggists in London, that their workmen are subject to ach, giddiness and stupor, if they do not carefully avoi dust thrown up while it is ground in the mill; and th men themselves are familiarly acquainted with this risk. analogous fact has likewise been communicated to me b *Hood* of this city relative to the effects of the seeds of t *lathyris*. A child two years of age ate some of the seed soon after vomited severely, which is the usual effect. I siness, however, succeeded; and after a few returns of v ing, which were promoted by an emetic, deep sleep gra came on, broken by convulsions, stertorous breathing and Sensibility was somewhat restored by blood-letting ar warm bath; after which the tendency to sleep was inter by frequent agitation and exercise in the open air. The ing then recurred for a time; but the child eventually go

Of Poisoning with the Seeds of the Castor-Oil Tree.

Castor-oil, at present so extensively used as a mild and tual laxative, is nevertheless derived from a plant hardly inferior in activity as a poison to that just considered. It is the expressed oil of the seeds of the *Ricinus communis* or Palma Christi. A good deal of discussion has taken place of late among chemists as to the source of the acrid properties of this seed, some supposing that they reside in the embryo, others in the perisperm, others in the cotyledon, others in a principle formed from the oil by heat; and the question is scarcely yet settled. It is probable, however, that, although castor oil owes its occasional acridity to changes effected by the heat to which it is sometimes exposed in the process of separation, nevertheless the cotyledons are in themselves acrid, as their taste indicates [*].

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[*] Archives Gén. de Méd. viii. 615.

[†] Journal de Chim. Méd. viii 671.

[‡] Orfila, Toxicol, Gén, i. 714.

[§] Botanical Arrangement, ii. 501. Stokes' Edition.

Two or three of the seeds will operate as a violent cathartic. *Bergius*, as quoted by Orfila, says he knew a stout man who was attacked with profuse vomiting and purging after having masticated a single seed.—*Lanzoni* met with an instance where three grains of the fresh seeds, taken by a young woman, caused so violent vomiting, hiccup, pain in the stomach, and faintness, that for some time her life was considered in great danger [†].—Dogs vomit so easily that they may take thirty seeds without material inconvenience, if the gullet is not tied. But if the gullet is secured, a much less quantity will occasion death in six hours. They produce violent inflammation when applied to a wound [‡].

Of Poisoning with the Jatropha.

The plants of the genus *Jatropha*, belonging to the same natural family, have all of them the same acrid properties as the castor-oil tree. The seeds of the *J. curcas*, the Physic-nut of the West Indies, when applied in the form of powder to a wound, produce violent spreading inflammation of the subcutaneous cellular tissue; and when introduced into the stomach they inflame that organ and the intestines [§]. Similar effects are produced by a fixed oil and by a volatile acid of a peculiar nature, which were procured from these seeds not long ago by *Pelletier and Caventou*. The oil to owe its properties to the acid. When separated l solvent action of alcohol, the oil is so active that four killed a blackbird in less than four-and-twenty hour when saponified by potass and then freed of its volatile distillation, it became inert. The acid, which possess peculiar odour of the seed, is still more powerful, a very quantity having killed a crow almost instantaneously. T is a powerful rubefacient, and if left too long in contac the skin, it will even produce a deep slough like the co mineral poisons *. Four seeds will act on man as a po cathartic. †

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[*] See on this subject *Deyeux* in Ann. de Chim. lxxiii. 106. *Boutron-Charlard et Henri*, in Journal de Pharmacie, x. 466. *Bussy et Lecanu*, ibid. xii. 481.

[†] Tractatus de Venenis in Opp. I. i. 308, quoted by *Marx*, die Lehre von den Giften, i. 128.

[‡] Toxicol. Gén. i. 706.

[§] Ibidem, i. 715.

Two other species have been examined, the *J. manih multifida;* both of which have been found equally delet The juice of the root of the *J. manihot*, or bitter cassada, ceedingly acrid; and many fatal mistakes have happened West Indies by the negroes taking it for the root of the *pha*, or sweet cassada. The latter does not contain an juice, and is eaten entire; but the juice of the former is so that, according to *Dr Clark* of Dominica, negroes hav killed in an hour by drinking half a pint of it ‡. The acri cies is rendered wholesome by a simple process, through of which the juice is removed, and little else left than f which then forms the Tapioca of the shops.

Of Poisoning with Manchineel.

The *Manchineel*, [*Hippomane mancinella*,] another pl the same natural family, contains a milky juice, which i sessed of very acrid properties. *Orfila* and *Ollivier* have some careful experiments with it on animals §, and *M.* has since added some observations on its effects on From the former it appears that two drachms of the jui plied to a wound in a dog will cause death in twenty hours, by exciting diffuse cellular inflammation; and tha that quantity will prove fatal in nine hours when intro into the stomach. From the observations of M. Ricord

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[*] Journal de Pharmacie, iv. 289.

[†] *Mr Bennet* in London Medical Gazette, ix. 7.

[‡] Med. Facts and Observations, vii. 293.

[§] Journ. de Chim. Méd. i. 343.

[‖] Ibidem, i. 483.

lows that inflammation is excited wherever the juice is applied, even on the sound skin; but he denies the generally received notion that similar effects ensue from sleeping under the branches of the tree, or from receiving drops of moisture from the leaves. This notion, however, it is right to add, has been adopted by other recent authors. *Descourtils* for example states that it is dangerous to sleep under the tree; that drops of rain from the leaves will blister any part of the skin on which they fall; and that on these accounts the police of St Domingo were in the practice of destroying the trees wherever they grew [*]. Other species of Hippomane are equally poisonous. The *H. biglandulosa* and *H. spinosa* are peculiarly so, especially the latter, which is known to the negroes of St Domingo by the name of Zombi apple, and is familiarly used by them as a potent poison [†].

Of Poisoning with Croton.

The oil of the *Croton tiglium* has been familiarly known for some years as a very powerful hydragogue cathartic in the dose of a few drops, and therefore little doubt can exist that both the oil and the seed which yields it must be active irritant poisons in moderate doses. Accordingly it has been lately found by experiments in Germany that forty seeds will kill a horse in the course of seven hours [‡]; and *Rumphius* mentions that it was a common poison in his time at Amboyna among the natives.

The next natural family in which plants are to be found that possess the properties of the acrid poisons, is the *Cucurbitaceæ*, or Gourds. This family, it should be remarked, does not in general possess poisonous properties. On the contrary, they are, with a few exceptions, remarkably mild; and many of them supply articles of luxury for the table. The melon, gourd, and cucumber belong to the order. The only poisons of the order which have been examined with any care are elaterium, bryony, and colocynth.

Of Poisoning with Bryony.

The root of the *Bryonia alba* of Linnæus, or *dioica* of other botanists, possesses properties essentially the same with those of euphorbium. The plant is a native of Britain, where it grows among hedges, and is usually known by the name of wild vine, or bryony. The flowers are greenish, and are succeeded by small, red berries. The root, which is the most active part of the plant, is spindle-shaped, and varies in size from that of a man's thigh to that of a radish.

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[*] Flora Medicale des Antilles, iii. 14.

[†] Ibidem, iii. 27.

[‡] *Landsberg*. Therapeutische und Toxikologische Würdigung der Grana Tiglii. Horn's Archiv. für Medizinische Erfahrung, 1831, 565.

Orfila found that half an ounce of the root introduced into the stomach of a dog, killed it in twenty-four hours, when the gullet was tied; and that two drachms and a-half applied to a wound brought on violent inflammation and suppuration of the part, ending fatally in sixty hours *.

The root of the bryony owes its power to an extractive matter which was discovered in it not long ago by *Brandes* and *Firnhaber*, and which they have named Bryonine. According to the experiments of *Collard de Martigny*, bryonine acts on the stomach and on a wound exactly as the root itself, and is considerably more energetic. When introduced into the cavity of the pleura it causes rapid death by true pleurisy, ending in the effusion of fibrin †.

Before the bryony root was expelled from medical practice, it was often known to produce violent vomiting, tormina, profuse watery evacuations, and fainting. *Pyl* mentions a fatal case of poisoning with it, which happened at Cambray in France. The subject was a man who took two glasses of an infusion of the root to cure ague, and was soon after seized with violent tormina and purging, which nothing could arrest, and which soon terminated fatally ‡. *Orfila* quotes a similar case from the Gazette de Santé, which proved fatal within four hours, in consequence of a strong decoction of an ounce of the root having been administered partly by the mouth and partly in a clyster to repel the secretion of milk §.

Of Poisoning with Colocynth.

Colocynth, or Bitter-apple, is another very active and more common acrid derived from a plant of the same family, the *Cu-*

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* Toxicol. Gén. i. 679.

† Nouv. Bibliothèque Médicale, Mai 1827, p. 221.

‡ Neues Magazin, i. 3, p. 557.

§ Toxicol. Gén. i. 680.

cumis colocynthis. It is imported into this country in the form of a roundish, dry, light fruit, as big as an orange, of a yellowish-white colour, unpleasant odour, and excessively bitter taste. Its active principle is probably a resinoid matter discovered by *Vauquelin*, which is very soluble in alcohol and sparingly so in water, but which imparts even to the latter an intensely bitter taste [*]. It is termed Colocynthin.

According to the experiments of Orfila, colocynth powder or its decoction produces the usual effects of the acrid vegetables on the stomach and on the subcutaneous cellular tissue. Three drachms proved fatal in fifteen hours to a dog through the former channel when the gullet was tied, and two drachms killed another in the same time when applied to a wound [†].

A considerable number of severe cases of poisoning with this substance have occurred in the human subject; and a few have proved fatal. *Tulpius* notices the case of a man who was nearly carried off by profuse, bloody diarrhœa, in consequence of taking a decoction of three colocynth apples [‡]. *Orfila* relates that of a rag-picker, who, attempting to cure himself of a gonorrhœa by taking three ounces of colocynth, was seized with vomiting, acute pain in the stomach, profuse diarrhœa, dimness of sight, and slight delirium; but he recovered under the use of diluents and local blood-letting [§]. In 1823 a coroner's inquest was held at London on the body of a woman who died in twenty-four hours with incessant vomiting and purging, in consequence of having swallowed by mistake a teaspoonful and a-half of colocynth powder [||]. *M. Carron d'Annecy* has communicated to Orfila the details of an instructive case, which also proved fatal. The subject was a locksmith, who took from a quack two glasses of decoction of colocynth to cure hemorrhoids, and was soon after attacked with colic, purging, heat in the belly and dryness of the throat. Afterwards the belly became tense and excessively tender, and the stools were suppressed altogether. Next morning he had also retention of urine, retraction of the testicles and priapism. On the third day the retention ceased, but the other symptoms continued, and the skin became covered with clammy sweat, which preceded his death only a few hours. The intestines were red, studded with black spots, and matted together by fibrinous matter; the usual fluid of peritonitis was effused into the belly; the villous coat of the stomach was here and there ulcerated: and the liver, kidneys, and bladder also exhibited traces of inflammation *.

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[*] Journal de Pharmacie, x. 416.

[†] Toxicol. Générale, i. 691.

[‡] Observat. Medicinales, iv. c. 27, p. 218.

[§] Toxicol. Générale, i. 695.

[||] London Courier, Sept. 9, 1823.

Of Poisoning with Elaterium.

Elaterium, which is procured from a third plant of the cucurbitaceæ, the *Momordica elaterium*, or spurting cucumber, possesses precisely the same properties with the two preceding substances. It appears, however, to be more active, for a single grain has been known to act violently on man. There can be no doubt that small doses will prove fatal; but its strength and consequently its effects are extremely uncertain. British elaterium, which is the feculence that subsides in the juice of the fruit, is the most powerful; French elaterium, which is the extract of the same juice, is much weaker; and a still weaker preparation sometimes made is an extract of the juice of the whole plant. The plant itself is probably poisonous. But the only case in point with which I am acquainted is a singular instance of poisoning, apparently produced in consequence of the plant having been carried for some time betwixt the hat and head. A medical gentleman in Paris, after carrying a specimen to his lodgings in his hat, was seized in half an hour with acute pain and sense of tightness in the head, succeeded by colic pains, fixed pain in the stomach, frequent watery purging, bilious vomiting, and some fever. These symptoms continued upwards of twelve hours †.

The active properties of this substance reside in a peculiar crystalline principle, discovered not long ago by *Dr Morries*, and named by him *Elaterine*. It is procured by evaporating the alcoholic infusion of elaterium to the consistence of thin oil, and throwing it into boiling distilled water; upon which a white crystalline precipitate is formed, and more falls down as the water cools. This precipitate when purified by a second solution in alcohol and precipitation by water, is pure elaterine.

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* Toxicol. Gén. i. 695.

† Annales d'Hygiène publique et de Méd. Lég. viii. 333.

In mass it has a silky appearance. The crystals are microscopic rhombic prisms, striated on the sides. It is intensely bitter. It does not dissolve in the alkalis, or in water, is sparingly soluble in diluted acids, but easily soluble in alcohol, ether and fixed oil. It has not any alkaline reaction on litmus.—It is a poison of very great activity. A tenth of a grain, as I have myself witnessed, will sometimes cause purging in man; and a fifth of a grain in two doses, administered at an interval of twenty-four hours to a rabbit, killed it seventeen hours after the second dose. The best British elaterium contains 26 per cent. of it, the worst 15 per cent.; but French elaterium does not contain above 5 or 6 per cent.[*] These facts account for the great irregularity in the effects of this drug as a cathartic. The principle discovered by Dr Morries was also discovered about the same time by *Mr Hennell*[†] of London. The substance procured some time ago by *Dr Paris*, and termed by him elatine, is a compound of elaterine and a resinoid matter like chlorophylle, the colouring principle of leaves.

Of Poisoning with the Ranunculaceæ.

The natural family of the Ranunculaceæ abounds in acrid poisons. Indeed few of the genera included in it are without more or less acrid property. This is a good illustration of a general law in nature,—that those plants resemble each other most in their effects on the animal system, which are also the most similar in outward characters.

The genus *Ranunculus* is of some interest to the British toxicologist, because many species grow in this country, and unpleasant accidents have been occasioned by them. The most common are the *R. bulbosus*, *acris*, *sceleratus*, *flammula*, *lingua*, *aquatilis*, *repens*, *ficaria*, which are all abundant in the neighbourhood of this city.—The *Ranunculus acris* is the only species that has been particularly examined. Five ounces of juice, extracted by triturating the leaves with two ounces of water, killed a stout dog in twelve hours when taken internally. Two drachms of the aqueous extract applied to a wound killed another in twelve hours by inducing the usual inflammation[‡].

Krapf, as quoted in Orfila's Toxicology, found by experiments on himself, that two drops of the expressed juice of *Ranunculus acris* produced burning pain and spasms in the gr and griping in the lower belly. A single flower had the s effect. When he chewed the thickest and most succulen the leaves, the salivary glands were strongly stimulated, tongue was excoriated and cracked, his teeth smarted, and gums became tender and bloody [*]. Dr Withering alleges it will blister the skin.—The acridity of the genus ranunc is entirely lost by drying either with or without artificial h The *R. acris*, however, is far from being the most active cies of the genus. The taste of the *R. bulbosus* I have fo to be much more pungent, also that of the *R. alpestris;* acridity of the *R. gramineus* is still more intense; and the m powerful of all is the unripe germens of the *R. sceleratus.* *R. repens*, *ficaria*, *auricomus*, and *aquatilis*, I have found to bland.

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[*] Edin. Med. and Surg. Journal, xxxv. 339.

[†] Journal of the Royal Institution, i. 532.

[‡] Toxicol. Générale, i. 754.

The genus *Anemone* produces similar effects on the ani economy. The most pungent species I have examined are *A. pulsatilla*, *A. hortensis*, and *A. coronaria;* the *A. nemoros* less active; and the *A. hepatica*, as well as the *A. alpestris*, bland. The powder of the *A. pulsatilla* causes itching of eyes, colic and vomiting, if in pulverizing it the operator do avoid the fine dust which is driven up; and *Bulliard* relates case of a man who, in consequence of applying the bruised r to his calf for rheumatism, was attacked with inflammation gangrene of the whole leg [†]. The same author mentions instance where violent convulsions were produced by an in sion of the *A. nemorosa*, and the person was for some ti thought to be in great danger [‡]. The acridity of the anem is retained under desiccation even in the vapour bath; bu very slowly lost under exposure to the air, not entirely, h ever, in two months. The ripe fruit of the *A. hortensi* bland.

The *Caltha palustris*, or Marsh Marigold, a plant closely lied in external characters to the Ranunculus, is considered toxicologists a powerful acrid poison. *Wibmer* observes th has an acrid, burning taste [§],—a remark which has been made by *Haller*[*]. On the continent the flower buds are said to be sometimes pickled and used for capers on account of their pungency. The following set of cases which happened in 1817 near Solingen will show that in some localities it certainly possesses energetic and singular properties. The poison was taken accidentally by a family of five persons, in consequence of their having been compelled by the badness of the times to try to make food of various herbs. They were all seized half an hour after eating with sickness, pain in the abdomen, vomiting, headach and ringing in the ears, afterwards with dysuria and diarrhœa, next day with œdema of the whole body, particularly of the face, and on the third day with an eruption of pemphigous vesicles as large as almonds, which dried up in forty-eight hours. They all recovered[†].

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[*] Toxicol. Générale, i. 754.

[†] Histoire des Plantes Vénéneuses de la France, p. 178.

[‡] Ibidem, 180.

[§] Die Wirkung der Arzneimittel und Gifte, i. 17.

Notwithstanding these apparently pointed facts, however, I have no doubt that the Marsh Marigold is in some circumstances bland, and is commonly so in this country, or at least but feebly poisonous. *Haller*, in speaking of its acrid taste, adds that when young it is eaten with safety by goats. For my own part I have never been able to remark any distinct acridity in tasting it either before inflorescence, or in the young flower-buds or in any part of the plant while in full flower. It produces a peculiar, disagreeable impression on the back of the tongue when collected in dry situations; but never occasions that pungent acridity which so remarkably characterizes many species of Ranunculus, Anemone, and Clematis.

The *Stavesacre*, or *Delphinium Staphysagria*, another plant of the same natural family, is interesting in a scientific point of view, because its properties have been distinctly traced to a peculiar alkaloid. The seeds, which alone have been hitherto examined, were analyzed with great care by *MM. Lassaigne* and *Feneulle*, who, besides a number of inert principles, discovered in them a ternary alkali or alkaloid, possessing in an eminent degree all the poisonous qualities of the seeds. This alkaloid is solid, white, pulverulent but crystalline, fusible like wax, very bitter and acrid, almost insoluble in water, very soluble in ether and alcohol, and capable of forming salts with most of the acids[‡].

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[*] Historia Stirpium Helvet.

[†] *Rust's* Magazin für die Gesammte Heilkunde, xx. 451.

[‡] Ann. de Chim. et de Phys. xii. 358.

It has been named *Delphinia*. It was also discovered abou same time by *Brandes* *.

Orfila found that six grains of it diffused through wate troduced into the stomach of a dog and retained there w ligature on the gullet, brought on efforts to vomit, restless giddiness, immobility, slight convulsions, and death in tw three hours. The same quantity, if previously dissolved i negar, will cause death in forty minutes. In the former but not in the latter, the inner coat of the stomach is foun be generally red †.

An ounce of the bruised seeds themselves killed a dog in four hours when introduced into the stomach, and two dra applied to a wound in the thigh killed another in two days. the former animal a part of the stomach was crimson-red the latter there was extensive subcutaneous inflammation re ing as high as the fourth rib ‡.

Besides these four genera of the Ranunculaceæ many o genera of the same natural order are equally energetic. *Clematis vitalba* or Traveller's-joy is said to be acrid, but not taste so: The *C. flammula* however is pungently acri the taste; it reddens and blisters the skin; and when swall ed excites inflammation in the stomach. The *Trollius* or g flower is also considered acrid; and its root in appearance, sn and taste, is said to resemble closely that of the Black Helleb The herb, however, has certainly none of the peculiar a pungency of the Ranunculus, Anemone or Clematis, but i the contrary bland. Some other genera of equal power been usually arranged with the Narcotico-acrid poisons on count of their action on the nervous system; and probably s of the present group of acrids might with equal propriety be moved to the same class.

Of plants possessing acrid properties and interspersed throu out other natural families, the only species I shall particul notice are the Mezereon, Cuckow-pint, Gamboge, Daffodil, lap-plant, and Savine.

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* *Schweigger's* Journal der Chemie, xxv. 369.

† Toxicol. Gén. i. 739.

‡ Ibidem, 741.

Of Poisoning with Mezereon.

The *Mezereon* and several other species of the genus Daphne to which it belongs are powerfully acrid. They belong to the natural order Thymeleæ. In the bark of the Mezereon, *M. Dublanc* has found a crystalline principle, in which the poisonous properties of the plant probably reside. It is neither acid nor alkaline. It is procured from the bark by boiling alcohol, and the subsequent action of ether on a confused crystalline mass which is left on evaporating the alcohol *.

The experiments of Orfila have been confined to a foreign species, the *D. gnidium* or *garou* of the French. Three drachms of the powder of its bark retained in the stomach of a dog killed it in twelve hours; and two drachms applied to a wound killed another in two days †. The action of the other species has not been so scientifically investigated; but fatal accidents have arisen from them when taken by the human species. Children have been tempted to eat the berries of the *D. Mezereon* by their singular beauty; and some, it is said, have died in consequence. *Vicat* relates the case of a man who took the wood of it for dropsy, and was attacked with profuse diarrhœa and obstinate vomiting, the last of which symptoms recurred occasionally for six weeks ‡. *Linnæus* in his *Flora Suecica* says that six berries will kill a wolf, and that he once saw a girl die of excessive vomiting and hæmoptysis, in consequence of taking twelve of them to check an ague §. The *D. Laureola* or spurge-laurel, a common indigenous species, abounding in low woods, is said by *Withering* to be very acrid, especially its root ‖.

Of Poisoning with Cuckow-pint.

The *Arum maculatum*, or Cuckow-pint, one of our earliest spring flowers, not uncommon in moist ground under the shelter of woods, is probably the most violent of all acrid vegetables inhabiting this country. I have known acute burning pain of the mouth and throat, pain of the stomach and vomiting, colic and some diarrhœa occasioned by eating two leaves. The genus possesses the same properties in other climates, the several species being every where among the most potent acrid poisons in their respective regions. The *Arum seguinum*, or dumb cane of the West Indies, is so active that two drachms of the juice have been known to prove fatal in a few hours [*]. It is not a little remarkable that the acridity of the arum is lost not merely by drying, but likewise by distillation. I have observed that when the roots are distilled with a little water, neither the distilled water nor the residuum possesses acridity.

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* Journal de Chim. Méd. v. 567.

† Toxicol. Gen. i. 703.

‡ Hist. des Plantes Vénén. de la Suisse, p. 140.

§ Flora Suecica, No. 338.

‖ Withering's Arrangement, i. 403, Stokes' Edition

Of poisoning with Gamboge.

The familiar pigment and purgative *Gamboge* is one of the pure acrids, and possesses considerable activity. It appears from the researches of *Orfila* [†], some experiments by *Schubarth* [‡], and various earlier inquiries quoted by *Wibmer* [§], that two drachms will kill a sheep; that a drachm and a half will kill a dog if retained by a ligature on the gullet, while much larger doses have little effect without this precaution, as the poison is soon vomited; that an ounce has little effect on the horse; that eighteen grains will prove fatal to the rabbit within twenty-four hours; and that the symptoms are such as chiefly indicate an irritant action. *Orfila* farther found that it produces intense spreading inflammation when applied to a recent wound, and in this way may occasion death as quickly and with as great certainty as when administered internally.

Gamboge in its action on man is well known to be one of the most certain and active of the drastic cathartics, from three to seven grains being sufficient to cause copious watery diarrhœa, commonly with smart colic. Larger doses will induce hypercatharsis. A drachm has proved fatal, as is exemplified by a case in the German Ephemerides where the symptoms were excessive vomiting, purging and faintness [||].

Under this head are probably to be arranged the repeated cases which have lately occurred in this country of fatal poisoning with a noted quack nostrum, Morison's Pills. Almost every physician in extensive practice has met with cases of violent hypercatharsis occasioned by the incautious use of these pills; and three instances are now on record where death was clearly occasioned by them *. No toxicologist will feel any surprise at such results, when he learns that one sort contains, besides aloes and colocynth, half a grain of gamboge, and another three times as much, in each pill; and that ten, fifteen, or even twenty pills are sometimes taken for a dose once or oftener in the course of the day †. The symptoms in the cases alluded to were sickness, vomiting and watery purging, pain, tension, fulness, tenderness and heat in the abdomen, with cold extremities and sinking pulse; and in the dead body the appearances were great redness of the stomach with softening of its villous coat, in the intestines softening and slate-gray coloration of the same coat, and in one instance the intestines were ulcerated.

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[*] *Descourtils.* Flora Médicale des Antilles, iii. 57.

[†] Toxicologie Générale, ii.

[‡] *Horn's* Archiv für Mediz. Erfahrung, 1824, i. 65.

[§] Die Wirkung der Arzneim. und Gifte, ii. 388.

[||] Acta Curios. Nat. Dec. 1. Ann. viii. p. 139.

Of Poisoning with Daffodil.

The common *Daffodil*, the *Narcissus pseudo-narcissus* of botanists, though commonly arranged with the vegetable acrids, seems not entitled to a place among them. At least the experiments of Orfila rather tend to show that it acts through absorption on the nervous system. Four drachms of the aqueous extract of this plant secured in the stomach in the usual way killed a dog in less than twenty-four hours; and one drachm applied to a wound killed another in six hours. In both cases vomiting or efforts to vomit seemed the only symptom of note; and in both the stomach was found here and there cherry-red. The wound was not much inflamed ‡.

Of Poisoning with Jalap.

Jalap, the powder of the root of the *Convolvulus Jalapa*, and a common purgative, is an active poison in large doses: and this every one should know, as severe and even dangerous effects have followed its incautious use in the hands of the practical joker. Its active properties reside in a particular resinous principle. It contains a tenth of its weight of mixed resin, which, like the resin of Euphorbium, has been separated by

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* Trial of *Webb*. London Med. Gaz. xiv. 612. Inquest on Rebecca Cross. Ibidem, 759. Case by Drs Labatt and Stokes. Dublin Journ. of Med. and Chem. Science, iv. 237.

† Analysis by Mr. West in the first of these cases.

‡ *Toxicol. Gen.* i. 744.

Drs Buchner and *Herberger* into two, one possessing some of the properties of acids, the other some of the properties of bases; and the latter they consider the active principle, and have accordingly named Jalapine [*]. *Mr Hume* of London some time ago procured from the crude drug a powdery substance, to which he gave the same name, and which he conceived to be the active principle. His analysis has not been generally relied on by chemists; but it is not improbable that his principle differs little from that of the German chemists. *Drs Buchner* and *Herberger* have the peculiar merit of showing, that the resin of jalap, as well as some other cathartic resins, is of a compound nature, and consists of two resinous principles, which perform the parts of acid and of base, although not possessed of the chief distinguishing properties of the common acids, alkalis or metallic oxides.

The action of jalap has been examined scientifically by *M. Felix Cadet de Gassicourt*, who found that it produced no particular symptom when injected into the jugular vein of a dog in the dose of twenty-four grains, or when applied to the cellular tissue in the dose of a drachm. But when rubbed daily into the skin of the belly and thighs it excited in a few days severe dysentery; when introduced into the pleura it excited pleurisy fatal in three days; when introduced into the peritonæum it caused peritonitis and violent dysentery fatal in six days; and when introduced into the stomach or the anus, the animals died of profuse purging in four or five days, and the stomach and intestines were then found red and sometimes ulcerated. Two drachms administered by the mouth proved fatal [†].—*Scammony*, which is procured from another species of the same genus, the *C. Scammonea*, has been found by Orfila to be much less active. Four drachms of the concrete juice of the root given to dogs produced only diarrhœa [‡].

Of Poisoning with Savin.

The leaves of the *Juniperus sabina*, or Savin, have been long known to be poisonous. They have a peculiar heavy, rather disagreeable odour, and a bitter, acrid, aromatic, somewhat resinous taste. They yield an essential oil, which possesses all their qualities in an eminent degree.

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[*] Repertorium für die Pharmacie, xxxvii.

[†] *Dissertation Inaugurale*, quoted in Orfila, Toxicol. Gén. i. 683.

[‡] Tox. Gén. i. 758. The drug must have been much adulterated, as it very generally is.

A dog was killed by six drachms of the powdered leaves confined in the stomach. It appeared to suffer pain, died in sixteen hours, and exhibited on dissection only trivial redness of the stomach. Two drachms introduced into a wound of the thigh caused death after the manner of the other vegetable acrids in two days; and besides inflammation of the limb there was found redness of the rectum [*].

Savin is a good deal used in medicine for stimulating old ulcers and keeping open blistered surfaces; which may be done without danger, although it cannot be applied to a fresh wound without exciting diffuse inflammation. Both the powder and the essential oil are of some consequence in a medico-legal point of view, as they have been often used with the intent of procuring abortion. The oil is very generally believed by the vulgar to possess this property in a peculiar degree. Doubts, however, may be entertained whether any such property is possessed by it independently of its operation as a violent acrid on the bowels. It has certainly been taken to a considerable amount without the intended effect; of which *Foderé* has noticed an unequivocal example. The woman took daily for twenty days no less than a hundred drops of the oil, yet carried her child to the full time [†]. The powder has likewise been taken to a large extent without avail. A female, whose case is noticed by Foderé, took without her knowledge so much of the powder that she was attacked with vomiting, hiccup, heat in the lower belly, and fever of a fortnight's duration; nevertheless she was not delivered till the natural time [‡]. There is no doubt, however, that if given in such quantity as to cause violent purging, abortion may ensue; but unless there is naturally a predisposition to miscarriage, the constitutional injury and intestinal irritation required to induce it are so great as to be always attended with great danger, independent of the uterine disorder. Of this train of effects the following case, for which I am indebted to *Mr Cockson* of Macclesfield, is a good illustration. A female applied to a pedlar to supply her with the means of getting rid of her pregnancy: and under his direction appears to have taken a large quantity of a strong infusion of savin-leaves on a Friday morning and again next morning. A very imperfect account was procured of the symptoms, as no medical man witnessed them; but it was ascertained that she had violent pain in the belly and distressing strangury. On the Sunday afternoon she miscarried; and on the ensuing Thursday she died. Mr Cockson, who examined the body next day, found extensive peritonæal inflammation unequivocally indicated by the effusion of fibrinous flakes,—the uterus presenting all the signs of recent delivery,—the inside of the stomach of a red tint, checkered with patches of florid extravasation,—and its contents of a greenish colour, owing evidently to the presence of a vegetable powder, as was proved by separating and examining it with the microscope.

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[*] *Orfila,* Toxicol. Gén. i. 724. [†] Méd. Légale, iv. 430. [‡] *Ibid.* iv. 431.

A singular case is quoted by *Wibmer* of a woman who died from taking an infusion of the herb for the purpose of procuring miscarriage, and in whom death seems to have been occasioned by the gall-bladder bursting in consequence of the violent fits of vomiting *.

In a charge of wilful abortion the mere possession of oil of savin would be a suspicious circumstance, because the notion that it has the power of causing miscarriage is very general and familiar with the vulgar; while it is scarcely employed for any useful purpose. The leaves in the form of infusion are in some parts of England a popular remedy for worms.

The following list includes all the other plants which have been either ascertained experimentally to belong to the present order, or are believed on good general evidence to possess the same or analogous properties.

By careful experiment Orfila has ascertained that the Gratiola officinalis, Rhus radicans and Rhus toxicodendron, Chelidonium majus and Sedum acre, possess them; and the following species are also generally considered acrid, namely Rhododendron chrysanthum and ferrugineum, Pedicularis palustris, Cyclamen Europæum, Plumbago Europæa, Pastinaca sativa, Lobelia syphilitica and longiflora, Hydrocotyle vulgaris. To these may be added the common Elder or Sambucus nigra, the leaves and flowers of which caused in a boy, who was my patient not long ago, dangerous inflammation of the mucous membrane of the bowels lasting for eight days.

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* Die Wirkung der Arzneimittel und Gifte, iii. 191.

CHAPTER XXI.

OF POISONING WITH CANTHARIDES.

The second groupe of the present Order of poisons comprehends most of those derived from the animal kingdom. In action they resemble considerably the vegetable acrids, their most characteristic effect being local inflammation; but several of them also induce symptoms of an injury of the nervous system. This groupe includes Cantharides, Poisonous Fishes, Venomous Serpents, and Decayed or Diseased animal matter.

The first of these is familiarly known as a poison even to the common people. I am not aware that it has ever been used for the purpose of committing murder. But on account of its powerful effect on the organs of generation it has often been given by way of joke, and has sometimes been taken for the purpose of procuring abortion. Fatal accidents have been the consequence.

The appearance of the fly is well known. When in powder, as generally seen, it has a grayish-green colour, mingled with brilliant green points. It has then a nauseous odour and a very acrid burning taste. Alcohol dissolves its active principle. This principle appears from a careful analysis by *M. Robiquet* to be a white, crystalline, scaly substance, insoluble in water, but soluble in alcohol as well as in oils, and termed Cantharidin*.

The subject of the detection of Cantharides in compound mixtures has not yet received much attention; but it appears from various researches, and more especially from a late inquiry in a medico-legal case by *M. Barruel*, that it may be sometimes detected,—on the one hand by the green colour and metallic brilliancy, even of its finest powder if examined in the sunshine—and on the other by making an etherial extract of the suspected matter, and producing with this extract the usual effects of a blister on a tender part of the arm. By these two tests Barruel discovered cantharides in chocolate cakes, part of which had been wickedly administered to ous individuals *.

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* Annales de Chimie, lxxvi.

SECTION I.—*Of the Action of Cantharides and the Sympto excites in Man.*

Cantharides, either in the form of powder, tincture, or solution, is an active poison both to man and animals. A its action on animals, *Orfila* found that a drachm and a-ha a strong oleaginous solution injected into the jugular vein dog killed it in four hours with symptoms of violent teta that three drachms of the tincture with eight grains of pov suspended in it caused death in twenty-four hours if reta in the stomach by a ligature on the gullet,—insensibility b then the chief symptom; and that forty grains of the pov killed another dog in four hours and a-half, although it allowed to vomit. In all the instances in which it was a nistered by the stomach, that organ was found much infla after death; and generally fragments of the poison were cernible if it was given in the form of powder. When app to a wound the powder excites surrounding inflammation; a drachm will in this way prove fatal in thirty-two hours w out any particular constitutional symptom except languor †

These experiments do not furnish any satisfactory proo the absorption of the poison, but rather tend to show th does not enter the blood. Such a conclusion, however, i not be too hastily drawn; since its well known effects on when used in the form of a blister lead to the conclusion it is absorbed, and that it produces its peculiar effects on urinary system through the medium of the circulation. account of the magnitude of the dose required to produce vere effects on animals, Orfila's experiments on the stomach external surface of the body cannot, for reasons formerly ass ed, [536,] be properly compared together.

Orfila has examined with care not only the preparation cantharides already mentioned, but likewise the various pri ples procured by M. Robiquet during his analysis; and it pears to result, that the active properties of the fly reside p ly in the crystalline principle, and partly in a volatile oil, which is the source of its nauseous odour.

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* Annales d'Hygiène Publique et de Medecine Légale, xiii. 455.

† Toxicol. Gen. ii. 4.

The symptoms produced by cantharides in man are more remarkable than those observed in animals. A great number of cases are on record; but few have been minutely related. Sometimes it has been swallowed for the purpose of self-destruction, and sometimes for procuring miscarriage; but most frequently, on account of a prevalent notion that it possesses aphrodisiac properties, it has been both voluntarily swallowed and secretly administered, to excite the venereal appetite. That it has this effect in many instances cannot be doubted. But the old stories, which have been the cause of its being so frequently used for the purpose, are many of them altogether fabulous, and all much exaggerated. Very often no venereal appetite is excited, sometimes even no affection of the urinary or genital organs at all; and the kidneys and bladder may be powerfully affected without the genital organs participating. It is established, too, by frequent observation, that the excitement of the genital organs can never be induced, without other violent constitutional symptoms being also brought on, to the great hazard of life.

The following abstract of a case by *M. Biett* of Paris gives a rational and unexaggerated account of the symptoms as they commonly appear. A young man, in consequence of a trick of his companions, took a drachm of the powder. Soon afterwards he was seized with a sense of burning in the throat and stomach; and in about an hour with violent pain in the lower belly. When M. Biett saw him, his voice was feeble, breathing laborious, and pulse contracted; and he had excessive thirst, but could not swallow any liquid without unutterable anguish. He was likewise affected with priapism. The pain then became more extensive and severe, tenesmus and strangury were added to the symptoms, and after violent efforts he succeeded in passing by the anus and urethra only a few drops of blood. By the use of oily injections into the anus and bladder, together with a variety of other remedies intended to allay the general irritation of the mucous membranes, he was considerably relieved before the second day; but even then he continued to complain of great heat along the whole course of the alimentary canal, occasional priapism, and difficult micturition.

For some months he laboured under difficulty of swallowi
—Another case very similar in its circumstances has been
lated by *M. Rouquayrol.* In addition to the symptoms obs
ed in Biett's patient there was much salivation, and tow
the close of the second day a large cylindrical mass of the
ner membrane of the gullet was discharged by vomiting †.

Among the symptoms the affection of the throat, causing
ficult deglutition and even an aversion to liquids, appears t
pretty constant. The sense of irritation along the gullet
in the stomach is also generally considerable. Sometimes
attended with bloody vomiting, as in four cases related by
Graaf of Langenburg ‡; and at other times, as in the inst
of poisoning with the acids, there is vomiting of membra
flakes. These have been mistaken for the lining membran
the alimentary canal, but are really in general a morbid se
tion §. At the same time there is reason to believe that a l
portion of the lining membrane of the gullet was discharge
Rouquayrol's case, for there were many ramified vessels in it,
one so large that blood was procured from it on pricking it
a lancet. A very prominent symptom in most cases is dist
sing strangury, generally connected with suppression of u
and the discharge of blood from the urethra ‖. It would
pear that, when the genital organs are much affected, the
flammation may run on to gangrene of the external p
Ambrose Paré notices a fatal instance of the kind, which
caused by a young woman seasoning comfits for her lover
cantharides ¶.

The preceding symptoms are occasionally united with si
of an injury of the nervous system. Headach is common,
delirium is sometimes associated with it. § In a case comm
cated to Orfila by one of his friends the leading symptom
first were strangury and bloody urine; but these were s
followed by violent convulsions and occasional loss of recol

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[*] *Orfila, Toxicol. Gén.* ii. 28.

[†] Annales de la Méd. Physiologique, Octobre 1829—extracted in Edin.
and Surg. Journal, xxxiv. 214.

[‡] *Hufeland's Journal der Praktischen Heilkunde,* lii. 2, 112.

[§] See an interesting case in *Memorie della Soc. Med. di Genova,* ii. 1, p.

[‖] Graaf's Cases, and Rouquayrol's.

[¶] Lib. xxi. *des Venins.*

tion[*]. The quantity in that instance was only eight grains; and it was taken for the purpose of self-destruction. In one of Graaf's four cases the patient was attacked during convalescence with violent frenzy of three days' continuance[†]. An instance is also related in the Transactions of the Turin Academy of tetanic convulsions and hydrophobia appearing three days after a small overdose of the tincture of cantharides was taken, and continuing for several days with extreme violence[‡]. The cause of the symptoms, however, is here doubtful.

The following fatal cases I have found recently recorded. Orfila quotes one from the *Gazette de Santé* for May 1819, which was caused by two doses of twenty-four grains taken with the interval of a day between them for the purpose of suicide. The ordinary symptoms of irritation in the bowels and urinary organs ensued, miscarriage then took place, and the patient died on the fourth day, with dilated pupils and convulsive motions, but with unimpaired sensibility[§]. Another instance related by *Dr Ives* of the United States, presents two stages, like that related by Orfila, but with the remarkable difference that an interval of several days intervened between the irritant and narcotic stages. A man swallowed an ounce of the tincture, and was seized in a short time with hurried breathing, flushed face, redness of the eyes and lacrymation, convulsive twitches, pain in the stomach and bladder, suppression of urine, and priapism; in the evening delirium set in, and next morning there was loss of consciousness; but from this time under the use of blood-letting, emetics, blisters, sinapisms, and castor-oil, he got well and continued so for fourteen days. But after that interval he was suddenly attacked with headach and shivering, then with convulsions, and subsequently with coma; which, however, was removed for a time by outward counter-irritants. Next day the coma returned at intervals, and on the subsequent day the convulsions also, which gradually increased in severity for three days more and then proved fatal[||]. In this case it admits of question whether the affection which proved the immediate cause of death really arose from the cantharides, or was an independent ease.—A third case, fatal on the fourth day, occurred in A 1830 near Uxbridge in the south of England. I have not able to learn the particulars exactly; but it appears to have produced by cantharides powder, which was mixed with by two scoundrels at a dancing party for the purpose of e ing the venereal appetite of the females. A large par young men and women were in consequence taken severel and one girl died, who had been prevailed on to take the der at the bottom of the vessel, on being assured it was gi

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[*] *Toxicol. Gén.* ii. 23.

[†] *Hufeland's Journal*, lii. 2. 114.

[‡] Mem. dell' Acad. de Torino, 1802–3.

[§] Toxicol. Gén. ii. 30.

[||] Medizinisch-Chirurgische Zeitung, 1834. iv. 298, from American Journal of Medical Science.

The quantity of the powder or tincture requisite to p fatal or dangerous has not been accurately settled. In practitioners differ much even as to the proper medicinal d It is probable that this is one of the poisons whose op tion is liable to be materially affected by idiosyncrasy. medicinal dose is from half a grain to two grains of the der, and from ten drops to two drachms of the tinctu But *Dr Beck* has quoted an instance where six ounces of tincture were taken without injury [†]. On the other *Werlhoff* has mentioned the case of a lad who used to b tacked with erection and involuntary emission on merely s ling the powder [‡]. This statement, though almost incred is not without support from the parallel effects of other stances.

SECTION II.—*Of the Morbid Appearances caused by Cantharides.*

The only precise account I have hitherto seen of the mo appearances caused by cantharides is contained in the his of the case from the *Gazette de Santé*. The brain was go with blood. The omentum, peritonæum, gullet, stomach testines, kidneys, ureters, and internal parts of generation inflamed; and the mouth and tongue were stripped of lining membrane.—In dogs *Schubarth* observed, besides usual signs of inflammation in the alimentary canal, great ness of the tubular part of the kidneys, redness and extrav ed patches on the inside of the bladder, and redness of

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[*] *Duncan's* Edinburgh Dispensatory.

[†] Medical Jurisprudence, 574; from New York Med. and Phys. Journal

[‡] *Mem. della Soc. Med. di Genova.* ii. 1. 29.

ureters as well as of the urethra [*]. In Dr Ives' case the blood-vessels of the brain and cerebellum were gorged, the cerebellum spread over with lymph, the villous coat of the stomach softened and brittle, and the kidneys inflamed and presenting blood in their pelvis.

It is of importance to add, that when the case has been rapid, the remains of the powder will probably be found in the stomach, and may be sought for by the process formerly mentioned. From the late researches of *Orfila* and *Lesueur*, it appears that it does not undergo decomposition for a long time when mixed with decaying animal matters. After nine months' interment the resplendent green points continue brilliant; and the powder may be separated by immersing the parts in boiling water. The fatty matter rises to the surface, while the cantharides powder falls to the bottom, and will be found to retain all its characteristic properties [†].

SECTION III.—*Of the Treatment of Poisoning with Cantharides.*

The treatment of poisoning with cantharides is not well established. No antidote has yet been discovered. At one time fixed oil was believed to be an excellent remedy. But the experiments of Robiquet on the active principle of the poison, and those of Orfila on the effects of its oleaginous solution, rather prove that oil is the reverse of an antidote. The case mentioned in the Genoa memoirs was evidently exasperated by the use of oil. When the accident is discovered early enough, and vomiting has not already begun, emetics may be given; and if vomiting has begun, it is to be encouraged. Oleaginous and demulcent injections into the bladder generally relieve the strangury. The warm-bath is a useful auxiliary. Leeches and blood-letting are required, according as the degree and stage of the inflammation may seem to indicate.

Many other insects besides the *Cantharis vesicatoria* possess the same acrid properties; but we are not sufficiently acquainted with them to render it necessary to notice them particularly. Two of them, however, may be briefly alluded to, because they

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[*] Archiv für medizinische Erfahrung, 1824, i. 61–64.

[†] Revue Médicale, 1828, ii. 475.

have caused fatal poisoning. The one is the *Meloë prosca*
bæus, the *maiwurm* of the Germans, a native of most Europ
countries. In Rust's Magazin there is an account of four p
sons who took the powder of this insect from a quack for spas
in the stomach. The principal symptoms were stifling and
miting; and two of the people died within twenty-four hour
The other is the *Bombyx*, of which at least two species are
lieved to possess powerful irritant properties, the *B. pityocam*
and *B. processionea*. The following is an instance of their
fects. A child ten years old had a common blister applied
the neck and spine as a remedy for deafness; and on the fou
day afterwards her mother dressed the abraded skin with t
leaves of the beet-root, from which she had previously shak
a prodigious number of caterpillars. The child soon complai
ed of insupportable itching and burning in the part on wh
the leaves were applied, cried out on account of the pain, a
endeavoured to tear off the dressings. The mother persev
ed, however; and her child died in two days of gangrene
the whole integuments of the back. The surgeon, who s
the child on the last day of her life, ascribed the gangrene
the insects mentioned above, and states that they possess t
power of exciting erysipelas when applied even to the sou
skin †. It is probable that many other insects in Europe ha
similar properties. The *Mylabris Cichorii*, which, according
Latreille ‡, is partially used in Italy and is in common use
China for blistering, must possess active irritant properties.

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* Magazin für die gesammte Heilkunde, xviii. 109.

† Journal Complémentaire, xviii. 184.

‡ Cuvier, Règne Animal, v. 63.

CHAPTER XXII.

OF THE DELETERIOUS EFFECTS OF POISONOUS FISH.

THE species of Fish which act deleteriously either always or in particular circumstances, have also been commonly arranged in the present Order of poisons.

The subject of Fish-poison is one of the most singular in the whole range of toxicology, and none is at present veiled in so great obscurity. It is well ascertained that some species of fish, particularly in hot climates, are always poisonous,—that some, though generally salubrious and nutritive, such as the oyster and still more the muscle, will at times acquire properties which render them hurtful to all who eat them,—and that others, such as the shell-fish now-mentioned, and even the richer sorts of vertebrated fishes, though actually eaten with perfect safety by mankind in general, are nevertheless poisonous, either at all times or only occasionally, to particular individuals. But hitherto the chemist and the physiologist have in vain attempted to discover the cause of their deleterious operation.

A good account of the poisonous fishes of the Tropics has been given by *Dr Chisholm* * and by *Dr Thomas* †; and some farther observations on the same subject have been published by *Dr Fergusson* ‡. These essays may be consulted with advantage. On the effects of poisonous muscles several interesting notices and essays have been written, among which may be particularized one by *Dr Burrows* § of London, another by *Dr Combe* of Leith ||, and the observations of *Professor Orfila*, including some cases from the Gazette de Santé, and from the private practice of *Dr Edwards* ¶. Of all the sources of information now mentioned, that which appears to me the most comprehensive and precise is the essay of Dr Combe, who has collected many facts previously known, added others equal in num-

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* Edin. Med. and Surg Journal, iv. 393.

† Memoirs of the London Medical Society, v. 94.

‡ Edin. Philos. Journal, i. 194.

§ Lond. Med. Repository, iii. 445.

|| Edin. Med. and Surg. Journal, xxix. 86.

¶ Toxicol. Gén. ii. 37.

ber and importance to all the rest put together, and weig with impartiality the various inferences which have been or be drawn from them. The succeeding remarks will be confi to a succinct statement of what appears well established.

In this work, however, the poisonous fishes of the West dies and other tropical countries may be laid aside, because are still too little acquainted with the phenomena of their tion to be entitled to investigate its cause, and they are obj of much less interest to the British medical jurist than the f poisons of his own coast.

There is little doubt that some of the inhabitants of the on the coasts of Britain are always poisonous. Thus it is known that some of the molluscous species irritate and infl the skin wherever they touch it,—a fact which is familia every experienced swimmer. The fishermen of the Eng coast are also aware that a small fish known by the fam name of Weever [*Trachinus vipera*, Cuv.] possesses the po of stinging with its dorsal fin so violently as to produce im diate numbness of the arm or leg, succeeded rapidly by co derable swelling and redness; and indeed an instance of accident, which lately happened at Portobello on the Firt Forth, has been mentioned to me by *Mr Stark*, author of Elements of Natural History, who witnessed the effects of poison. But our knowledge of the poisons of that class is imperfect to require more particular notice.

Of fishes which are commonly nutritive, but sometimes quire poisonous properties, by far the most remarkable is common *Muscle*. Opportunities have often occurred for obs ing its effects,—so often, indeed, that its occasional poiso qualities have become an important topic of medical police, in some parts, as in the neighbourhood of Edinburgh and L it has of late been abandoned by many people as an artic food, although generally relished, and in most circumstances doubtedly safe. This result originated in an accident w happened at Leith in 1827, and by which no fewer than tl people were severely affected and two killed.

Of the Symptoms and Morbid Appearances caused by Poiso Muscles.

The effects of poisonous muscles differ in different c

Sometimes they have produced symptoms of local irritation only. Thus *Foderé* mentions the case of a sailor at Marseilles, who, in consequence of eating a large dish of them, died in two days, after suffering from vomiting, nausea, pain in the stomach, tenesmus, and quick contracted pulse. The stomach and intestines were found after death red and lined with an abundant tough mucus [*]. One of the cases described by *Dr Combe*, which, however, terminated favourably, is of the same nature. The patient had severe stomach symptoms from the commencement, attended with cramps and ending in peritonitis, which required the frequent use of the lancet.

But much more commonly the local effects have been trifling, and the prominent symptoms have been almost entirely indirect and chiefly nervous. Two affections of this kind have been noticed. One is an eruptive disease resembling nettle-rash, and accompanied with violent asthma; the other a comatose or paralytic disorder of a very peculiar description.

Of the former affection several good examples have been recorded in different numbers of the Gazette de Santé [†]. In these the number of muscles eaten was generally small; in one instance ten, in another only six. Nay, in a case related with several others by *Möhring* in the German Ephemerides, the patient only chewed one muscle and swallowed the fluid part, having spit out the muscle itself [‡]. The symptoms have usually commenced between one and two hours after eating, and rapidly attained their greatest intensity. In the patient who was affected by ten muscles the first symptoms were like those of violent coryza; swelling and itching of the eyelids, and general nettle-rash followed; and the eruption afterwards gave place to symptoms of the most urgent asthma, which were removed by ether. In other cases the symptoms of asthma preceded the eruption. In one instance the eruption did not appear at all. The swelling has not been always confined to the eyelids, but, on the contrary, has usually extended over the whole face. All the patients were quickly relieved by ether. The eruption, though generally called nettle-rash, is sometimes papular, sometimes vesicular, but always attended with tormenting heat and it ness. Several cases of this kind have been related by *M ring*. The eruption was preceded by dyspnœa, lividity of face, insensibility, and convulsive movements of the extremi All recovered under the use of emetics *. This affection, h ever, may prove fatal. In the cases of two children relate Dr Burrows, the symptoms began, as in Möhring's cases, w dyspnœa, nettle-rash, and swelling of the face, combined w vomiting and colic; but afterwards the leading symptoms w delirium, convulsions, and coma; and death took place in th days.

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[*] Médecine Légale, iv. 85.

[†] 1er Mars 1812; 1er Octobre 1812; 21 Mars 1813; 11 Avril 1813.

[‡] De Mytilorum quorundam veneno,—Acta Physico-Medica Acad. Cæsareo-Leopoldino-Carol. &c. 1744. Appendix, p. 124.

In these children it is worthy of remark, that none of symptoms began till twenty-four hours after eating. In M ring's cases, on the contrary, the symptoms began in a few nutes.

The other affection is well exemplified in the correct d neations of Dr Combe. The following is his general summ of the cases; which, with the exception of the instance of ritonitis already alluded to, were all singularly alike in th leading features.—" None, so far as I know, complained of thing peculiar in the smell or taste of the animals, and none fered immediately after taking them. In general, an hour two elapsed, sometimes more; and then the bad effects cons ed rather in uneasy feelings and debility, than in any distr referable to the stomach. Some children suffered from eati only two or three; and it will be remembered that Roberts a young and healthy man, only took five or six. In two three hours they complained of a slight tension at the stoma One or two had cardialgia, nausea, and vomiting; but th were not general or lasting symptoms. They then complain of a prickly feeling in their hands; heat and constriction of t mouth and throat; difficulty of swallowing and speaking freel numbness about the mouth, gradually extending to the arm with great debility of the limbs. The degree of muscular d bility varied a good deal, but was an invariable symptom. some it merely prevented them from walking firmly, but in m of them it amounted to perfect inability to stand. While lyi in bed they could move their limbs with tolerable freedom; b on being raised to the perpendicular posture, they felt th limbs sink under them. Some complained of a bad coppery taste in the mouth, but in general this was an answer to what lawyers call a leading question. There was slight pain of the abdomen, increased on pressure, particularly in the region of the bladder, which suffered variously in its functions. In some the secretion of urine was suspended, in others it was free, but passed with pain and great effort. The action of the heart was feeble; the breathing unaffected; the face pale, expressive of much anxiety; the surface rather cold; the mental faculties unimpaired. Unluckily the two fatal cases were not seen by any medical person; and we are therefore unable to state minutely the train of symptoms. We ascertained that the woman, in whose house were five sufferers, went away as in a gentle sleep; and that a few minutes before death, she had spoken and swallowed *." She died in three hours. The other fatal case was that of a dock-yard watchman, who was found dead in his box six or seven hours after he ate the muscles.

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* De Mytilorum, &c. p. 115.

The inspection of the bodies threw no light on the nature of these singular effects. No appearance was found which could be called decidedly morbid. The stomach contained a considerable quantity of the fish half-digested.

Dr Combe's narrative agrees with that of *Vancouver*, four of whose sailors were violently affected, and one killed in five hours and a half, after eating muscles which they had gathered on shore in the course of his voyage of discovery †.

In closing this account, allusion may be briefly made to a case related by *Dr Edwards*, which differs from all the preceding. The symptoms were uneasiness at stomach, followed by epileptic convulsions, which did not entirely cease for a fortnight. Dr Edwards imputed the illness to muscles; but it must be observed that this is a solitary instance of simple convulsions arising from such a cause ‡. The case deserves particular attention, because a suspicion of intentional poison might have been excited by the circumstances in which it occurred. The individual, a young man, was attacked soon after eating in company with another, who was about to marry his mother, and with whom on that account he lived on bad terms.

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* Edin. Med. and Surg. Journal, xxix. 88.

† Voyage of Discovery, ii. 285.

‡ Orfila, Toxic. Gén. ii. 44.

Of the Source of the Poison of Muscles.

Various opinions have been formed as to the cause or (of the poisonous qualities of some muscles.

The vulgar idea that the poisonous principle is copper, which the fish becomes impregnated from the copper bo of vessels, is quite untenable. Copper does not cause the s toms described above. I analyzed some of the muscles from the stomach of one of *Dr Combe's* patients, without able to detect a trace of copper; and others have arrived same result in former cases.

The theory which ascribes their effects to changes in by decay is equally untenable. In *Dr Burrows's* two case muscles appear to have been decayed; yet he very proper fuses to admit this fact as explanatory of their operation. indeed, it rather complicates than facilitates the explanatio it shows that the poison differs from animal poison gene in not being destroyed by putrefaction. Dr Combe's inq should satisfy every one, that in the Leith cases decay wa of the question, and I may add my testimony to his staten The muscles taken from the stomach of one of the fatal (and likewise others which were procured in the shell fr family that suffered, and which were brought to me for a sis, were perfectly fresh.

By some physicians, and especially by *Dr Edwards*, poisonous effects have been referred to idiosyncrasy on the of the persons who suffer. It can hardly be doubted that is really the cause in some instances. It was formerly tioned that muscles, oysters, crabs, and even the richer of vertebrated fishes, such as trout, salmon, turbot, hol herring, mackarel, are not only injurious to some people, salutary to mankind generally, but likewise that this sin idiosyncrasy may be acquired. A relation of mine for years could not take a few mouthfuls of salmon, trout, her turbot, holibut, or lobster, without being attacked in a few nutes or hours with violent vomiting; yet at an early p of life, he could eat them all with impunity; and at all he has eaten without injury cod, ling, haddock, whiting, f der, oysters, and muscles. Among the cases which have under Dr Edwards's notice in Paris, there is one evidently same nature. In two others, the idiosyncrasy existed in regard to the muscle, and although in both of these the affection induced was slight, there is no doubt but idiosyncrasy will also account even for some instances of the severe disorders specified above. In particular, it appears sometimes to operate in the production of nettle-rash and asthma; for in the instance quoted from the Gazette de Santé, as arising from ten muscles, it happened that the father of the patient partook very freely of the same dish without sustaining any harm whatever; and in each of three distinct accidents mentioned by Möhring, it appeared that other individuals had eaten of the same dish with equal impunity *.

But idiosyncrasy will not account for all the cases of poisoning with muscles, oysters, and other fish. For, passing over other less unequivocal objections, it appears that, when the accident related above happened at Leith, every person who ate the muscles from a particular spot was more or less severely affected; and an important circumstance then observed for the first time was, that animals suffered as severely as man, a cat and a dog having been killed by the suspected article.

Another theory ascribes the poisonous quality to disease in the fish; but no one has hitherto pointed out what the disease is. The poisonous muscles at Leith were large and plump, and seemed to have been chosen on account of their size and good look. *Dr Coldstream*, however, at the time a pupil of this University, and a zealous naturalist, thought that the liver was larger, darker, and more brittle than in the wholesome fish, and certainly satisfied me that there was a difference of the kind. But whether this was really disease or merely a variety of natural structure, our knowledge of the natural history of the fish hardly entitles us to pronounce.

Considering the failure of all other attempts to account for the injurious properties acquired by muscles, it is extraordinary that no experiments have been hitherto made with the view of discovering in the poisonous fish a peculiar animal principle. It certainly seems probable, that the property resides in a particular part of the fish or in a particular principle. In 1827, I made some experiments on those which caused the fatal accident at Leith, but without success. My attention was turned particularly to the liver; but neither there nor in the other parts of the fish could I detect any principle whicl not equally exist in the wholesome muscle. This result, l ever, should not deter others, any more than it would m from a fresh investigation; for the want of a sufficient su prevented me from making a thorough analysis; and the re will presently find an instance related, where another sin poison, sometimes contained in sausages and in cheese, after repeated failures, at length traced successfully to the cause by the hand of the analytic chemist.

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* De Mytilorum, &c. p. 117, 121, 124.

M. Lamouroux, in a letter to Professor Orfila, conject that the poison may be a particular species of Medusa, enters into some ingenious explanations of his opinion. it is not supported by any material fact, and seems to be rounded by insuperable difficulties [*]. It is not a new co ture; for Möhring mentions in his paper formerly quoted, several writers before him had conceived such a cause m afford an explanation of the phenomena [†].

Little or no light is thrown on this singular subject by nature of the localities in which the poisonous muscle has l found. Even on this point we possess little information. I in Dr Burrows's and Dr Combe's cases the fish was attache wood. At Leith they were taken from some Memel fir l which formed the bar of one of the wet-docks, and had there at least fifteen years. From the stone-walls of the d in the immediate vicinity of this bar muscles were taken wl proved quite wholesome. It is hardly possible, however, to tach any importance to these facts; for Dr Coldstream info me, that he examined muscles which were attached to the piles of the Newhaven Chain-pier about a mile from Leith, found them wholesome. In the latter animals the liver not large, as in the poisonous muscles of Leith. Lamour states, but I know not on what authority, that muscles ne become poisonous unless they are exposed alternately to air and the sea in their place of attachment, and unless the flows in gently over them without any surf,—these conditi being considered by him requisite for the introduction of poisonous Medusæ into the shell.

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[*] Toxicol. Gén. ii. 45.

[†] De Mytilorum, &c. p. 134.

Of Poisonous Oysters.

Oysters sometimes acquire deleterious properties analogous to those acquired by muscles. But fewer facts have been collected regarding them. *M. Pasquier* has mentioned some cases which occurred not long ago at Havre, in consequence apparently of an artificial oyster-bed having been established near the exit of the drain of a public necessary. But I have not been able to consult his work[*]. Another instance of their deleterious operation occurred a few years ago at Dunkirk. At least an unusual prevalence of colic, diarrhœa, and cholera was believed to have been traced to an importation of unwholesome oysters from the Normandy coast. *Dr Zandyk*, the physician who was appointed to investigate the matter, found that the suspected fish contained a slimy water, and that the membranes were retracted from the shell towards the body of the animal[†]. *Dr Clarke* believes that even wholesome oysters have a tendency to act deleteriously on women immediately after delivery. He asserts that he has repeatedly found them to induce apoplexy or convulsions; that the symptoms generally came on the day after the oysters were taken; and that two cases of the kind proved fatal[‡]. I am not aware that these statements have been since confirmed by any other observer.

Of Poisonous Eels.

Eels have also been at times found in temperate climates to acquire poisonous properties. *Virey* mentions an instance where several individuals were attacked with violent tormina and diarrhœa a few hours after eating a paté made of eels from a stagnant castle-ditch near Orleans; and in alluding to similar accidents having previously happened in various parts of France, he adds that domestic animals have been killed by eating the remains of the suspected dish[§].

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[*] Journal de Pharmacie, v. 25. Essai Médical sur les huitres.

[†] London Med. Repository, xiii. 58.

[‡] Trans. London Coll. of Phys v. 109.

[§] Journal de Pharmacie, v. 509.

CHAPTER XXIII.

OF POISONING BY VENOMOUS SNAKES.

ANOTHER entire groupe of poisons allied to the acrid v tables in their action, but infinitely more energetic, com hends the poisons of the venomous serpents. If we we trust the impressions the vulgar entertain of the effects of bite of serpents, the poisons now mentioned would be c dered true *Septics* or putrefiants; for they were once unive ly believed, and are still thought by many, to cause putr tion of the living body. This property has been assigned t probably on no other grounds, except that they are apt to b on diffuse subcutaneous inflammation, which frequently run to gangrene. But there are some serpents, especially am those of hot climates, which appear also to act remotely on centre of the nervous system, and to occasion death thro means of that action.

The present groupe of poisons is of little consequence to British medical jurist, as an opportunity of witnessing thei fects in this country is seldom to be found. The *Viper* is only poisonous snake known in Britain, where its poiso hardly ever so active as to occasion death *.

This serpent, like all the other poisonous species, is pro ed with a peculiar apparatus by which the poison is secre preserved, and introduced into the body of the animal it atta The apparatus consists of a gland behind each eye, of a m branous sac at the lateral and anterior part of the upper j and of a hollow curved tooth surrounded and supported by sac. The cavity of the tooth communicates with that of sac, and terminates near the tip, in a small aperture, by wh the poison is expelled into the wound made by the tooth.

The symptoms caused by the bite of the viper are lanci ing pain, which begins between three minutes and forty minu after the bite, and rapidly stretches up the limb,—swelling first firm and pale, afterwards red, livid and hard,—tendency fainting, bilious vomiting, sometimes convulsions, more rarely jaundice,—quick, small, irregular pulse,—difficult breathing, cold perspiration, dimness of vision, and injury of the mental faculties. Death may ensue. A case is related in Rust's Magazin of a child twelve years old, who died two days after being bitten in the foot [*]; another instance is briefly noticed in the French Bulletins of Medicine, where a person forty years old died also in two days [†]; *Dr Wagner* of Schlieben mentions his having met with two instances where persons bit on the toes died before assistance could be procured [‡]; and very lately notice has been taken in Hufeland's Journal of a girl, eleven years old, having been killed in three hours at Schlawe in Prussia [§]. In the last case burning in the foot, which was the part bitten, then severe pain in the belly, inextinguishable thirst, and vomiting, preceded a fit of laborious breathing, which ushered in death. The most remarkable instance, however, of death from the bite of the European viper is one lately described by *Dr Braun*, as having been occasioned in the Dutchy of Gotha by the Coluber Chersea [Kreuzotter of the Germans]. A man who represented himself to be a snake-charmer insisted on showing his skill before Dr Lenz, a naturalist of Schnepfenthal; and putting the head of a viper belonging to this gentleman's collection into his mouth, he pretended to be about to devour it. Suddenly he threw the snake from him, and it was found that he had been bitten near the root of the tongue. In a few minutes he became so faint that he could not stand, the tongue swelled a little, the eyes became dim, some saliva issued from the mouth, rattling respiration succeeded, and he died within fifty minutes after being bitten [‖]. A French writer observes that the common viper of France is not very deadly; but that the bite of the red viper may occasion death in a few hours [¶].

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* For a severe case, not fatal, occurring in Kent, see London Medical Ga xii. 464.

The activity of the poison of the viper depends on a variety of circumstances. When kept long confined the animal loses its energy; and after it has bitten repeatedly in rapid succession, its bite ceases for some time to be poisonous, as the supply of poison is exhausted. It appears also to be most in hot and dry climates. Those cases are always the mo vere in which the symptoms begin soonest; and the d increases with the number of bites. An important obs tion made by *Dr Wagner* is that danger need not be d ed except when the bite is inflicted on small organs such fingers or toes, because larger parts cannot be fully inc between the animal's jaws, and fairly pierced by its fang can only be scratched. The properties of the fluid cont in the reservoir do not cease with the animal's life; nay continue even when the fluid is dried and preserved for a l of time. It may be swallowed in considerable quantity out causing any injury whatever. In the course of som periments lately made in Italy, a pupil of *Professor M* swallowed at once the whole poison of four vipers withou fering any inconvenience; and that of six vipers was giv a blackbird, that of ten to a pigeon, and that of sixteen to ven, with no other effect beyond slight and transient stupo

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[*] Magazin für die gesammte Heilkunde, xx. 155.

[†] Bulletins des Sciences Médicales, x. 92.

[‡] Ibidem, xx. 195.

[§] Journal der Praktischen Heilkunde, 1829, ii. iv. 120.

[‖] Rust's Magazin für die gesammte Heilkunde, xxxii. 361.

[¶] *Robineau-Devoidy* in Archives Gén. de. Méd. xxi. 626.

For the most recent account of the far more terrible e of the Cobra di Capello and Rattlesnake, the reader may to the authorities below [†].

There might also be arranged in an appendix to the pre groupe of poisons those *Insects* whose sting is poisonous. European insects known to have a poisonous sting are ch the Scorpion, Tarantula, Bee and Wasp; of which the last only are natives of Britain.

The poison of these insects occasions diffuse cellular inf mation, which always ends in resolution. It is said, howev and it may be readily believed, that death has been someti caused in consequence of a whole hive attacking an intr and covering his body with their stings. In an old Fr Journal is shortly noticed the case of a peasant who died after being stung over the eye by a single bee [§]. A more bable story has been told in the Gazette de Santé of a gard who died of inflammation of the throat, in consequence of b

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[*] *Giornale di Fisica*, ix. 458, and *Meckel's* Archiv für Anat. and Physic 639.

[†] Edin. Med. and Surg. Journal, xviii.; Phil. Trans. 1810.

[‡] Wibmer, Die Wirkung der Arzneimittel und Gifte, i. 203.

[§] Journal de Médecine, 1765.

stung there by a wasp while he was eating an apple, in which it had been concealed [*]. But the same accident has often occurred without any material danger.

The treatment of poisoning by the venomous serpents need not be detailed here. The subject is introduced merely to mention, that the treatment of poisoned wounds by the application of cupping-glasses has been lately resorted to with success for curing the bite of the viper. A patient of *M. Piorry* two hours after being bitten had all the constitutional symptoms strongly developed, such as slow, very feeble pulse, nausea, vomiting and swelling of the face. When a cupping-glass was applied for half an hour, the general symptoms ceased and did not return. Next day diffuse inflammation began; but it was checked by leeches [†]. An equally successful case is related in the Calcutta Transactions by *Mr Clarke* [‡].

[*] Gazette de Santé, 1776.

[†] Archives Générales de Médecine, xi. 80.

[‡] Trans. of Med. and Phys. Soc. of Calcutta, iv. 442.

CHAPTER XXIV.

OF POISONING BY DISEASED AND DECAYED ANIMAL MAT

Another and much more important groupe of poison may be arranged in the present Order comprehends a matter usually harmless or even wholesome, but rendere leterious by disease or decay. These poisons are form three ways, by morbid action local or constitutional, by nary putrefaction, and by modified putrefaction.

Of Animal Matter rendered poisonous by Diseased Actio

Under the first variety might be included the latent po by means of which natural diseases are communicated by i tion, contact, and inoculation. Such poisons, however, b usually excluded from a strict toxicological system, the onl rieties which remain to be noticed are the animal poisons gendered by disease, and which do not produce peculiar dise but merely inflammation. Several species of this kind ma mentioned, comprehending the solids and fluids in various healthy states of the body.

One of these poisons, contained in the blood and perhap some of the secretions of overdriven cattle, arises under circ stances in which the body seems to deviate very little from natural condition. A good account of the effects thus indu has been given in an essay on the subject by *Morand*[*]. Fr the cases he describes it follows, that the flesh of such anim is wholesome enough when cooked and eaten; but that if blood or raw flesh be applied to a wound or scratch, nay e sometimes to the unbroken skin, a dangerous and often f inflammation is excited, which at times differs little from fuse cellular inflammation, and at other times consists of a neral eruption of gangrenous boils, the *pustules malignes* of French. The deleterious effects occasionally observed to a from offal are probably analogous in their nature and t cause. On this subject *Mr Brodie* has lately made some-marks which tend to show that the application of various kinds of offal to wounds, and especially pricks of the fingers with spiculæ of bone from the hare, may cause an obstinate chronic erysipelas of the hand *. I have met with a case of this nature, where the affection was erratic erythema of the hand.

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[*] Histoire d'une Maladie très-singulière, &c. in Hist. de l'Académie des S ces, 1766, i. 97.

Another species of poison allied to the preceding in its effects and equally obscure in its nature includes certain fluids of the human body after natural death, which are probably modified, if not even formed altogether, by morbid processes during life. Such poisons are the most frequent source of the dreadful cellular inflammation, which has lately been often witnessed as the consequence of pricks received during dissection by the anatomist. On this interesting but obscure subject, much minute information will be found in the works quoted below †.

It is still a matter of question among pathologists what these poisons are, and in what circumstances they spring up. By some their baneful properties have been suspected to arise from the operation of particular diseases on natural or morbid secretions ‡; and although the precise diseases inducing these properties, and the precise fluids which acquire them have by no means been satisfactorily ascertained, it appears to be well established that no fluid possesses them more frequently or in a higher degree than the serum which is effused into the cavities of the chest and belly by recent inflammation of the serous membranes of these cavities. By others the origin of the poison is suspected to be wholly independent of diseased action in the living body, and to lie merely in certain changes effected in healthy secretions by decay. And as the accidents produced by this poison have occurred chiefly during the dissection of bodies recently dead, it is supposed to exist only for a short time at the commencement of decay, and to disappear in the farther progress of putrefaction.

But whatever may be its nature and origin, we are well enough acquainted with its effects; which are diffuse inflam-

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* London Med. and Phys. Journal, lvii. 342.

† Dr Duncan's Cases of Diffuse Inflammation of the cellular texture—in Edin. Med. Chirug. Trans. i. 455, 470. 1824. Also,

‡ Mr. Travers on Constitutional Irritation. 1826.

mation and violent constitutional excitement, rapidly p to a state resembling typhoid fever. Sometimes the i mation spreads steadily towards the trunk from the part to the poison was applied; sometimes the inflammation arou injury is trifling and limited, but a similar inflammation a in or near the axilla, and subsequently on other parts body; and the latter form of disease is always attended the highest constitutional injury and with the greatest da

Another singular poison, unequivocally the product o ease, and which acts as a local irritant, is the flesh or flu animals affected at the time of their death with a carb lar disorder, denominated in Germany *Milzbrand*, and a gous to the *Pustule maligne* of the French. The disea far as I know, has not received a vulgar name in the En language, being fortunately rare in Britain. It is a con tional and epidemic malady, which sometimes prevails ar cattle on the continent to an alarming extent, and is chara ized by the eruption of large gangrenous carbuncles on va parts of the body. This distemper has the property of dering the solids and fluids poisonous to so great a degree, not only persons who handle the skin, entrails, blood, or o parts, but even also those who eat the flesh, are apt to s severely. The affection thus produced in man is someti ordinary inflammation of the alimentary canal, or choler more commonly a disorder precisely the same as the Pu maligne †; but most frequently of all an eruption of on more large carbuncles resembling those of the original dis of the cattle ‡. It is often fatal. The carbuncular form been known to cause death in forty-eight hours §. It is a rious fact, for the knowledge of which we are indebted to *Dupuy*, that the carbuncle of cattle may be caused by appl to a wound the blood or spleen of an animal killed by grangr of the lungs ‖.

A poison analogous to the former in its nature, which sometimes occasioned severe and even fatal effects in man is matter of *glanders*, a contagious disease to which the hor peculiarly subject, and which is communicated probably by means of a morbid secretion from the nostrils. This disease has been communicated to man by infection; at least instances have been related where grooms attending glandered horses, although they had no external injury through which inoculation could take place, were attacked with profuse fetid discharge from the nostrils, a pustular eruption on the face, and colliquative diarrhœa, which has sometimes ended fatally in a few days[*]. In other instances inoculation of the hand with the blood of the glandered horse has produced alarming diffuse inflammation, and a carbuncular eruption[†].

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* Rust's Magazin, xxiv. 490.

† Ibidem, xxv. 108.

‡ Kopp's Jahrbuch, v. 67, and vi. 95.

§ Rust's Magazin, xxv 105.

‖ Révue Médicale, 1827. ii. 488.

It appears probable, that some peculiar circumstances with which we are not yet acquainted must concur with the operation of the poisons now under review, before they can take effect. At least unequivocal facts have been published which show, that the fluids and solids, as well as the emanations of animals infected and even killed by glanders or the *Pustule maligne* may be often handled and breathed with impunity. Such is the result of a very careful inquiry made under the direction of the Parisian Board of Health into the nuisance occasioned by the great *Nackery* of Montfaucon[‡]. *Parent-Duchatelet*, the author of an elaborate report on the subject, considers it clearly established that neither the workmen nor the horses connected with the establishment, nor the tanners who are supplied with hides from it, have ever presented a single instance of disease referrible to the operation of diseased animal matter. Yet upwards of twelve thousand horses are annually flayed there, and among these it is calculated that at least three thousand six dred are affected with carbuncle, glanders, or farcy [*].

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[*] Journal der Praktischen Heilkunde, liv. iii. 62.

[†] Magazin der Ausländischen Literatur, iii. 460. v. 168.

[‡] I having taken the liberty of applying this term to an establishment unique perhaps in the history of the world. The *Voirie et Chantier d'Ecarrissage* of Montfaucon, which has existed close to the walls of Paris for several centuries, is an enclosure of many acres, where the contents of the necessaries of the city are collected in enormous pits, and where horses, dogs, and cats are flayed to the amount of forty or fifty thousand annually. The fat is melted for blowpipe-lamps; the bones are in a great measure burnt on the premises for fuel; the intestines are made into coarse gut for machinery; the flesh, blood, and garbage are heaped to putrefy for manure; and in summer a bed of compost is spread to breed maggots for feeding poultry. There is no drain. Description cannot convey an idea of the stench there exhaled. The committee of the Board of Health, appointed to make inquiries into the best mode of abating the nuisance, in vain attempted to penetrate into the place. Yet the workmen and their families are stout, healthy, and long-lived.

Of Animal matter rendered poisonous by Common Putrefac

The second mode in which animal matters, naturally w some or harmless, may acquire the properties of irritant sons, is by their undergoing ordinary putrefaction.

The tendency of putrefaction to impart deleterious qua to animal matters originally wholesome has been long kn and is quite unequivocal. To those who are not accustom the use of tainted meat, the mere commencement of decay is ficient to render meat insupportable and noxious. Game decayed enough to please the palate of the epicure, has ca severe cholera in persons not accustomed to eat it in that s The power of habit, however, in reconciling the stomach t digestion of decayed meat is inconceivable. Some epicur civilized countries prefer a slight taint even in their beef mutton; and there are tribes of savages still farther adva in the cultivation of this department of gastronomy, who with impunity rancid oil, putrid blubber, and stinking offal. I far putrefaction may be allowed to advance without overpo ing the preservative tendency of habit, it is not easy to tell. with the present habits of this and other civilized nations, limit appears very confined.

Putrid animal matter when injected into the veins of hea animals proves quickly fatal; and from the experiments of *pard* and *Magendie* [†], together with the more recent resear of *MM. Leuret* and *Hamont* [‡], the disease induced seems to semble closely the typhoid fever of man.

Similar effects were observed by Magendie, when dogs w confined over vessels in which animal matter was decaying that they were obliged always to breathe the exhalation These discoveries throw some light on the question regard the tendency of putrid effluvia to engender fever in man; notwithstanding many well ascertained facts of an opposite port, they show that, probably in peculiar circumstances, decaying animal matter may excite epidemic fevers. A detailed investigation of this important topic would be misplaced here, as it belongs more to medical police than to medical jurisprudence; but the two works quoted below are referred to for examples, in my opinion, of the unequivocal origin of continued fever in the cause now alluded to *.

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[*] Des Chantiers d'Ecarrissage. Annales d'Hyg. Publ. et de Méd. Lég 139. Sur l'enfouissement des Animaux morts de maladies contagieuses. ix. 109.

[†] Journal de Physiologie, ii. 1, and iii. 81.

[‡] Journal des Progrès des Sciences Médicales, 1827, vi. 181.

[§] Journal de Physiologie, iii. 85.

Another affection sometimes brought on by putrid exhalations is violent diarrhœa or dysentery, of which a remarkable instance lately occurred in the person of a well-known French physician, *M. Ollivier.* While visiting a cellar where old bones were stored, he was seized with giddiness, nausea, tendency to vomit and general uneasiness; and subsequently he suffered from violent colic with profuse diarrhœa, which put on the dysenteric character and lasted for three days †. *Chevallier* in noticing this accident mentions his having been affected somewhat in the same way when exposed to the emanations of dead bodies; and it is a familiar fact that medical men, who engage in anatomical researches after long disuse, are apt to suffer at first from smart diarrhœa.

The same remark must be applied here as at the close of the observations in the last section. Without peculiar concurring circumstances no bad effect results. This will follow from many facts illustrative of the innocuous nature of various trades where the workmen are perpetually exposed to the most noisome putrid effluvia. But no facts of the kind are so remarkable as those collected in regard to the establishment at Montfaucon by *Parent-Duchatelet*, who makes it appear that this most abominable concentration of the worst of all possible nuisances is not merely not injurious to the health of the men and animals employed in and around it, but actually even preserves them from epidemic or epizootic diseases ‡.

The effects of putrid animal matter when applied to wounds have been investigated experimentally by *Professor Orfila;* who found that putrid blood, bile, or brain, caused death in this way within twenty-four hours,—producing extensive local inflammation of the diffuse kind, and great constitutional fe In man also several instances of diffuse cellular inflammat have been observed as the consequence of pricks received d ing the dissection of putrid bodies. The disease, as forme observed, certainly arises in general from pricks received dissecting recent bodies. At the same time, a few cases h been traced quite unequivocally to inoculation with putrid m ter[*]; and if any doubts existed on this point, the experime of Orfila would remove them.

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* De divers accidens graves occasionnés par les miasmes d'animaux en putréfaction. Mém. de la Soc. Roy. de Méd. i. 97.—London Med. Chirurg. Review, vi. 202.

† Annales d'Hyg. Publique et de Méd. Légale, vii. 216.

‡ Ibidem, viii. and ix. *ut supra.*

M. Lassaigne has examined chemically the putrid mat formed by keeping flesh long in close vessels, and has found to consist of carbonate of ammonia, much caseate of ammon and a stinking volatile oil,—the last of which is probably t poisonous ingredient.

Of Animal Matter rendered poisonous by Modified Putrefacti

The third way in which animal matters naturally wholeso may become irritant poisons, is by their undergoing a modifi putrefaction.

In this way three common articles of food in Germany a apt to acquire very dangerous properties, namely a particul kind of sausage, a particular kind of cheese, and bacon. T last species of poison has been occasionally observed in Franc and probably occurs in Britain also. But the two first ha been hitherto met with only in some districts of Germany.

The best account yet given of the *Sausage-poison* is contai ed in two essays published not long ago by *Dr Kerner*[†], in late Thesis by *Dr Dann*[‡], and in a Prize-essay by *Dr Horn*[§]. It has at various times committed great ravages i Germany, especially in the Würtemberg territories, where 23 cases of poisoning with it occurred between the years 1793 an 1827; and of that number no less than 110 proved fatal[‖].

The symptoms of poisoning seldom begin till twenty-four, o even forty-eight hours after the noxious meal, and rather later than earlier. The tardiness of their approach seems owing to the great indigestibility of the fatty matter with which the active principle is mixed. The first symptoms are pain in the stomach, vomiting, purging, and dryness of the mouth and nose. The eyes, eyelids, and pupils then become fixed and motionless; the voice is rendered hoarse, or is lost altogether; the power of swallowing is much impaired; the pulse gradually fails, frequent swoonings ensue, and the skin becomes cold and insensible. The secretions and excretions, with the exception of the urine, are then commonly suspended; but sometimes profuse diarrhœa continues throughout. The appetite is not impaired; fever is rarely present; and the mind continues to the last unclouded. Fatal cases end with convulsions and oppressed breathing between the third and eighth day. In cases of recovery the period of convalescence may be protracted to several years. The chief appearances in the dead body are the signs of inflammation in the mucous membrane of the alimentary canal,—whiteness and dryness of the throat, thickening of the gullet, redness of the stomach and intestines; also croupy deposition in the windpipe; great flaccidity of the heart; and a tendency in the whole body to resist putrefaction.

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[*] Dr Duncan, Edin. Med. Chirurg. Trans. i. 502 and 520.

[†] Neue Beobachtungen über die Vergiftungen durch den genuss geraücher Würste. Tübingen, 1820.—Das Fettgift, oder die Fettsaüre, und ihre Wirku gen auf den thierischen Organismus. Tübingen, 1822.

[‡] De Veneni Botulini viribus et natura. Diss. Inaug. Berolini, 1828.

[§] De Veneno in Botulis. Commentatio in certamine lit. a gratioso Med. Or Berol. Præmio ornata. 1828. Analyzed by *Dr Arrowsmith* in Edin. Med. a Surg. Journal, xxxiii. 28.

[‖] *Horn's* Archiv, 1828, i. 558.

The sausage which is apt to occasion these baneful effects is of two sorts, the white and the bloody sausage *(leberwürste, blut-würste.)* Both are of large size, the material being put into swine's stomachs; and they are cured by drying and smoking them in a chimney with wood-smoke. Those which have been found to act as poisons possess an acid reaction, are soft in consistence, have a nauseous, putrid taste, and an unpleasant sweetish-sour smell like that of purulent matter. They are met with principally about the beginning of spring, when they are liable to be often alternately frozen and thawed in the curing. Those sausages only become poisonous which have been boiled before being salted and hung up. They are poisonous only at a particular stage of decay, and cease to be so when putrefaction has advanced so far that sulphuretted-hydrogen is evolved. The central part is often poisonous when the surface is wholesome.

Various opinions have been entertained of the cause of the deleterious qualities thus contracted. In recent times the principle has been supposed to be pyroligneous acetic acid, hyd cyanic acid, or cocculus indicus. *Dr Kerner*, however, has sho that none of these notions will account for the phenomena; at first conceived he had proved the poisonous principle to fatty acid analogous to the sebacic acid of Thenard, and ori nating in a modified process of putrefaction. From the pois ous sausage he procured by double decomposition an acid si lar in chemical properties to that procured from fat by destr tive distillation; and by experiments on animals he thought observed, that the acid procured in either way produced sy toms analogous to those of poisoning with the deleterious s sage. Subsequently, however, he changed his views in so measure; and he now considers that the poison is a compou one consisting of a fatty acid analogous to the sebacic, and o volatile principle [*]. The results obtained very recently by *Dann* coincide with the last opinion. Dann infers from his searches that the poisonous principle does not necessarily resi in an acid, but is an acrid empyreumatic oil, which when pu is not active, but is rendered so by uniting with various fa acids [†].

The results lately obtained by *Buchner* after an elaborate a careful analysis are somewhat different and probably nearer t truth. He first ascertained that the product of the distillati of fat has no analogy with the sausage-poison. He found it consist of animalized acetic acid, and a fetid empyreumatic the former of which had no injurious effect on animals, wh the latter, though an active poison, was purely narcotic in operation. On next examining a sausage sent to him fro Würtemberg, which had violently affected four individuals a killed one of them in six days, he remarked that the poisono principle is not soluble in water, and is not carried over wi water which is distilled from it; that cold alcohol removes granular fatty matter, which, when purified by distilled wat has a yellowish colour, a peculiar nauseous smell, and a disagre able oleaginous taste, followed by extraordinary dryness of t throat for several hours. Although it does not possess an a reaction on litmus, it forms a soap with alkalis, and is separ ed again by acids unchanged; and consequently it may be considered a fatty acid, to which Buchner proposes to give the name of Botulinic acid [Würst-fett-saüre]. It concentrates in itself the poisonous properties of the crude sausage. Thirty grains of it, which formed three-fourths of the whole product of a single sausage, were given in two doses to a puppy with an interval of a day between them. For some hours after the second dose no apparent effect was produced. But gradually the animal became dull, lay in the same spot, wasted rapidly away notwithstanding a vigorous appetite, and died of exhaustion on the thirteenth day. Half a grain causes insupportable dryness in the throat, which does not go off for several hours[*]. With these results the contemporaneous and unconnected researches of *Dr Schumann* accord very remarkably. Alcohol boiled on the poison-sausage deposited on cooling a fatty matter, which, when washed with distilled water, possessed all the properties specified by Buchner as characterizing his fatty acid, and acted on animals in the same way as the sausage-poison[†].

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[*] *Weiss.* die neueste Vergift. durch Verdorbene Würste, &c. mit Vorrede Anhang begleitet. von *Dr J. Kerner.* Carlsruhe, 1821.

[†] *Horn's* Archiv, 1828, i. 596.

The *Poison of Cheese* has been longer and more generally known; and several detailed descriptions of its effects may be seen in late German journals. *Dr Henneman* has published an interesting essay on several cases which happened at Schwerin in 1823[‡]. Another account of a similar accident which happened at Minden in 1825 has been published in Rust's Magazin[§]. But by far the best information on the subject is to be obtained from two papers in late numbers of Horn's Archiv, —the one by *Professor Hünefeld* of Greifswald, describing the phenomena as he witnessed them in that city in 1827, and containing an elaborate chemical analysis and physiological experiments, by means of which he conceives he has discovered the deleterious principles contained in the cheese[‖],—the other by *Dr Westrumb* of Hameln, who investigated the particulars of seven cases which came under his notice in 1826, and with the of Sertürner, the chemist, traced the properties of the poiso almost the same principles with those indicated by the researc of Hünefeld [*]. Besides the cases which have given origin these papers, others have occurred throughout Germany in same period; and during the third quarter of last century t kind of poisoning was so common, that several of the Gern states investigated the subject, and legislative enactments w passed in consequence.

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[*] Toxikologie, Zweite Aufl. 1829, p. 136.

[†] Das Wurst-fett-gift, oder neue Untersuchung, &c. Archiv für Medizinische Erfahrung, 1829, i. 30 and 75.

[‡] Hufeland's Journal, lvii. 2. 106.

[§] Magazin für die gesammte Heilkunde, xxi. 247.

[‖] *Die Chemische Ausmittelung des Käsegifts.* Horn's Archiv, 1827, i. 203.

For a long time the prevalent belief was, that the cheese quired an impregnation from copper vessels used in the d ries; and accordingly the Austrian, Wirtemberg and Ratesb States prohibited the use of copper for such purposes. T opinion, however, was proved by chemical analysis to be un nable; and the inquiries of Hünefeld and Sertürner have n rendered it probable that the poisonous property of the che resides in two animal acids, analogous, if not identical, w the caseïc and sebacic acids, and consequently that the poiso ous cheese belongs to the same genus with the noxious sausag

The mode in which the formation of these acids is accou ed for is as follows. According to the researches of Proust t sharp peculiar taste of old cheese is owing to the gradual co version of the curd or caseïn into the caseate of ammonia, whi in sound cheeses is always united with an excess of alkali. the cheese in question (*barscher-käse*, *quark-käse*, *hand-käs* the curd, before being salted, is left for some time in a heap ferment, in consequence of which it becomes sour and afte wards ripens faster. But if the milk has been curdled wi vinegar,—if the acid liquor formed while it ferments is n carefully drained off,—if the fermentation is allowed to go t far—if too little salt is used in preserving the curd,—or flour has been mixed with the curd, the subsequent ripeni or decaying of the cheese follows a peculiar course, and a co siderable excess of caseïc acid is formed, as well as some seb cic acid.

The poisonous cheeses, according to *Westrumb*, present peculiarity in their appearance, taste, or smell. But *Hünef* says that they are yellowish-red, soft, and tough, with hard and darker lumps interspersed, that they have a disagreea taste, redden litmus, and become flesh-red instead of yellow, under the action of nitric acid.

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[*] *Ueber die Vergiftung durch Käse.* Horn's Archiv, 1828. i. 65.

The symptoms they cause in a man appear to be nearly the same with those produced by the poisonous sausage, and usually commence, according to Hünefeld, in five or six hours, according to Westrumb, in half an hour. They constitute various degrees and combinations of gastro-enteric inflammation. In the most severe of Hünefeld's cases the quantity taken did not exceed four ounces, and was sometimes only an ounce.

The same author found that a drachm and a-half of the caseïc acid, which he procured from the cheese, killed a cat in eight minutes, and the same quantity of the sebacic acid another in three hours. His experiments, however, are not quite conclusive of the fact that these acids are really the poisonous principles, as he has not extended his experimental researches to the caseïc and sebacic acids prepared in the ordinary way. His views will probably be altered and simplified, if future experiments should confirm the late inquiries of *Braconnot*, who has stated that Proust's caseïc acid is a modification of the acetic, combined with an acrid oil *. Westrumb procured analogous results with those of Hünefeld when he gave to animals the acid fat which he separated in the course of his analysis.

The poisonous cheese has been hitherto met with only in some parts of Germany. But from information communicated to me not long ago by *Dr Swanwick* of Macclesfield, there is some reason to think that a parallel poison is occasionally met with in Cheshire, among the small hill-farms, where the limited extent of the dairies obliges the farmer to keep the curd for several days before a sufficient quantity is accumulated for the larger cheeses. It is hardly necessary to add, that analogous properties may be imparted to cheese by the intentional or accidental addition of other poisons of a mineral nature. This subject has been already alluded to in the section upon Lead.

As connected, though indeed but remotely, with the cheese-poison, some notice may be here taken of a peculiar mode in which it has been supposed that *Milk* may acquire the properties of an acrid poison. It has been several times remarked on the continent, that the milk even of the cow, but more parti-

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* Ann. de Chimie et de Physique, xxxvi. 159.

cularly that of the ewe and goat, may act like a violent pois
although no mineral or other deleterious impregnation co
be detected in it; and these effects have been variously
vaguely ascribed to the animal having been diseased, or to
having fed on acrid vegetables, which pass into the milk wi
out injury to its health, because though poisonous to most a
mals, they are not so to the Ruminantia. This singular to
cannot be thoroughly investigated, as precise facts are s
wanting. But the two following examples of the accident
luded to may be mentioned. One occurred very lately at A
rillac, a village in France. Fifteen or sixteen customers o
particular dealer in goat's milk were at one and the same ti
attacked with all the symptoms of violent cholera; and ab
twenty-four hours afterwards the goat too was taken ill w
the same affection and died in three days *. The other insta
occurred lately at Hereford in Westphalia. Six people of
family, after partaking of goat's butter-milk, were simultaneo
ly attacked with violent vomiting, tension of the epigastriu
and retraction of the lower belly; and several of them suffer
so severely as even to have been thought by their physicia
Dr Bonorden, to be in danger †. *Dr Westrumb* has alluded
similar cases in his memoir on the poison of cheese, and h
proved that the ordinary explanations of them are far from s
tisfactory. Among other judicious observations he remar
that the poison has been generally believed to arise sometim
from the cattle having fed on the *Euphorbia esula*, a species
spurge; that, according to Viridet in his *Tractatus de Prin
Coctione*, l. i. c. 15, certain fields in the neighbourhood of En
brim were of necessity abandoned by the shepherds, becau
the milk of their cows was rendered useless by the abundan
of that plant among the herbage; but that he himself has fou
the cattle will not touch it so long as grass and other whol
some vegetables are to be found in the pasturage ‡. *Professo
Orfila* and *Marc*, who were appointed by the Society of Med
cine of Paris to report upon the accident at Aurillac, state, th
in parallel cases which had been referred to them by the Poli
at Paris they had been unable to detect any mineral poiso

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* Archives Générales, xv. 460.

† Rust's Magazin, xxvii. 193.

‡ Horn's Archiv, 1828, i. 76.

that none of the received explanations are in their opinion satisfactory; and that they are disposed to ascribe the poisonous alteration of the milk to new principles formed by a vital process.

Another common article of food, which has occasionally produced similar effects with the poisonous sausages and cheese, is *Bacon*. *Dr Geiseler* has related an accident which occurred in a family of eight persons, and which he traced to this cause. The symptoms were almost exactly the same with those described by *Kerner*, with the addition, however, of delirium and loss of recollection; and in two they were so violent as seriously to endanger life. The father of the family alone escaped, having stewed his bacon, while the rest ate it raw [*]. His escape might have arisen from the fatty acid having been decomposed, or the acrid oil expelled, by the heat.—It is not improbable that other varieties of cured meat may also become poisonous. *Cadet de Gassicourt* mentions, that he had been frequently desired by the police to examine cured meat which had produced symptoms of poisoning at Paris [†], and *Orfila* makes the same remark in his Lectures on Medical Jurisprudence [‡]. As the meat always came from the shops of meat-curers, and did not contain any mineral poison, it probably owed its qualities to the same ingredient as the bacon in Geiseler's cases. A full and interesting account of an accident of the kind has also been lately given by *M. Ollivier*, of which the following is an analysis. Three members of a family at Paris, on the day after eating a ham-pye, were seized with shivering, cold sweats, violent pain in the stomach, frequent vomiting, burning thirst, excessive tenderness of the belly, profuse purging and colic; but they all recovered under antiphlogistic treatment. On subsequent inquiry it appeared that about the same period several customers of the pastry-cook who supplied the pye had been similarly affected; and consequently an investigation was made into the cause under the authority of the police. After a very careful analysis, however, by *MM. Barruel* and *Ollivier*, it was clearly made out, that the pye did not contain a trace of any of the

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[*] Rust's Magazin, xvi. 111.

[†] London Medical and Physical Journal, xlvi. 68.

[‡] *Orfila*, Médecine-Légale, ii. 322.

common mineral poisons; and therefore the only concl
Ollivier conceived it possible to draw was, that the ham
acquired the properties of the poisonous sausage or chees
Germany [*]. Two similar reports have been since publis
one by *MM. Lecanu, Labarraque,* and *Delamorlière,* anothe
Chevallier; and both agree in ascribing the poisonous effec
the decay of the meat, the ordinary poisons having been sou
for in vain. In the cases examined by Chevallier, the art
was a sort of sausage, called in Paris "Italian Cheese,"
made of the debris of various kinds of meat, especially por

Effects somewhat similar have been observed from spoi
Goose-grease, used in dressing food. *Dr Siedler* has related f
cases where violent symptoms were thus induced. Two ad
and two children, after eating a dish seasoned with goose-grea
were seized with giddiness, prostration of strength, anxie
sweating,—burning pain in the lower belly, aggravated by pr
sure,—violent vomiting, in one case sanguinolent,—involunt
stools and urine, and dilatation of the pupil. In one of the adu
there was also complete insensibility, with imperceptible pu
for six minutes. No metallic poison could be found. T
grease was acid, and of a repulsive odour; and three oun
given to a dog acted violently and in the same manner [‡].

Another article of food which has appeared occasionally
produce parallel effects is *Smoked Sprats.* An instance of th
injurious operation is briefly described in the work quoted b
low [§]. Putrid *Pickled Salmon* has occasioned death in t
country [‖]; and I may mention that I have known most viole
diarrhœa occasioned in two instances by a very small porti
of the oily matter about the fins of *Kipper* or smoked salmo
so that I have no doubt a moderate quantity would produ
very serious effects.

Although these illustrations of the effects of modified putr
faction in rendering wholesome meat noxious have been tak
in a great measure from continental experience, this has be
done rather because the subject has been more fully and acc
rately investigated there, than because similar poisons are u

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[*] Archives Gén. de Méd.

[†] Journ. de Chim. Méd. viii. 728.

[‡] Journal of the Institution, ii. 414, from Hufeland's Journal.

[§] Bulletins des Sciences Méd. xx. 197.

[‖] London Med. Gazette, xiv. 656.

known in Britain. The defective system of Medical Police in this country would allow such accidents as those mentioned above to pass sometimes without notice, and almost always without scientific examination; but it must not therefore be supposed that they are wholly unknown.

The following incident, which happened a few years ago on the Galloway coast, is an instance of poisoning not less alarming than any of those which have occurred in Germany. In the autumn of 1826 four adults and ten children ate at dinner a stew made with meat taken from a dead calf, which was found by one of them on the sea shore, and of which no history could be procured. For three hours no ill effect followed. But they were then all seized with pain in the stomach, efforts to vomit, purging, and lividity of the face, succeeded by a soporose state like the stupor caused by opium, except that when roused the patient had a peculiar, wild expression. One person died comatose in the course of six hours. The rest, being freely purged and made to vomit, eventually got well; but for some days they required the most powerful stimulants to counteract the exhaustion and collapse which followed the sopor. The meat, they said, looked well enough at the time it was used. Yet the remains of the dish which formed the noxious meal had a black colour and nauseous smell; and some of the flesh which had not been cooked had a white, glistening appearance, and was so far decayed that its odour excited vomiting and fainting *. It is much to be regretted that this accident was not properly inquired into. The only conjecture which the facts will warrant as to the cause of the poisonous quality of the meat is, that in consequence of having lain long in the water, the flesh had begun to undergo the adipocirous putrefaction; and that in the course of the changes thus induced the meat became impregnated with the poisonous principle of the German sausages or cheese.

An accident of a similar nature, for the particulars of which I am indebted to *Dr Swanwick* of Macclesfield, also occurred at Stockport in the summer of 1830. A family of five persons took for dinner broth made of beef, which, owing to its black colour, the master of the family had previously said to his wife he thought bad and unfit for use. In the course of some

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* London Med. Repository, *Third Series*, iii. 372.

hours two boys were attacked with sickness and vomitin
appear to have got soon well, probably from the early discl
of the poison. Next morning a washerwoman who had
with the family was seized with violent pain in the bowels,
rhœa, racking pains and weakness in the limbs, and did no
cover for ten days. On the evening of the second day the
ter of the house was similarly affected, and was ill for a
night. And a day later his wife was also seized with a si
disorder, preceded by soreness of the throat and tongue
difficulty of swallowing, and ending fatally in fourteen
The last person was previously in delicate health, and su
to disorder in the stomach and bowels. The investiga
made by the police authorities into the circumstances of thi
cident was extremely imperfect; but there seems little re
to doubt that unsound meat was the cause.

CHAPTER XXV.

OF POISONING BY MECHANICAL IRRITANTS.

The *Fifth* Order of the Irritant class of poisons includes Mechanical Irritants.

These substances have not properly speaking any poisonous quality; but occasion symptoms like those of poisoning, and even sometimes death itself, in consequence of their mechanical qualities only. They have therefore been excluded from every toxicological system proposed in recent times; but in a medicolegal work on poisoning it would be wrong to pass them without notice.

The most important of the mechanical irritants are those which cause injury by reason of their roughness, sharpness, or size.

Many instances have occurred of persons having swallowed fragments of steel, copper, iron, broken glass, or entire prune-stones, cherry-stones, and the like,—who not long afterwards were attacked with signs of inflammation, or some other abdominal disease, and were carried off by it as by the administration of poison. The disorders thus induced are almost always of a chronic or lingering kind, and commonly depend on the gradual perforation of the intestines by the foreign body pressing on the coats. In general the person's illness ends in inflammation of the peritonæum. Sometimes the irritating substance perforates the skin and muscles as well as the intestines, and escapes outwardly; and a few individuals have even recovered under these circumstances. An excellent account of the ordinary phenomena in such accidents is given in the London Medical and Physical Journal. The person swallowed a chocolate nut, and after experiencing many uneasy sensations throughout the belly for several days, was attacked with peritonitis and died *. *Mr Howship* has related the particulars of the case of a woman, who died after two years of constant suffering, in consequence of having swallowed a large quantity of cherry-stones[*]. *Dr Marcet* has also described the case sailor who died in a similar way after swallowing several clasp-knives[†]. Many other examples might be referre but these will suffice for information on the ordinary effe mechanical irritants of the kind under consideration.

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* London Medical and Physical Journal, xxxv. 100.

From the case of Dr Marcet and other similar facts, i pears that large and even angular bodies do not always serious mischief, nay that they have been frequently swall without any material injury. Dr Marcet's sailor in the cc of his life had repeatedly swallowed several clasp-knives in q succession; and nevertheless recovered perfectly after some of slight illness. As to prune and cherry-stones, buttons, c needles, pins, and the like, they have been very often ta and even sometimes in large quantities, without any harm. is indeed extraordinary, and almost incredible, if the facts v not authenticated beyond the possibility of a doubt, how m mechanical irritation the alimentary canal has been subje to, without sustaining any injury. Many singular instance this effect have been related in the various medical journal Europe. At the head of the list, however, may be placed following, which is related by the late *Professor Osiande* Göttingen, in his work on Suicide.

A young German nobleman tried to kill himself in a fit insanity by swallowing different indigestible substances, without success. He never suffered any particular incon nience except a single attack of vomiting daily, though in course of seven months after being detected he passed the f lowing articles by stool—150 pieces of sharp, angular gl some of them two inches long—102 brass pins—150 iron n —three large hair-pins, and seven large chair-nails—a pair shirt-sleeve buttons—a collar buckle, half of a shoe-buckle, a three bridle-buckles—half a dozen sixpenny pieces—three hoo and a lump of lead—three large fragments of a curry-co and fifteen bits of nameless iron articles, many of them t inches in length[‡].

Before such articles occasion serious harm, it is necess that some cause coincide, by means of which the foreign bodies are detained long in the same part of the intestines; otherwise the irritation they produce is too trivial to excite disease.

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[*] Observations on Surgery, 276.

[†] London Medico-Chirurgical Transactions, xii. 52.

[‡] Ueber den Selbstmord, p. 168, from *Schmucker's* Vermischte Chirurg Schriften.

The only substance of this kind which it is necessary to particularize is *Pounded Glass.* It is a common notion that pounded glass is an active poison. There is no doubt, indeed, that it does possess some irritant properties even when finely pulverized, for it titillates and smarts the nostrils, and inflames the eyes. There is also little doubt that when swallowed in fragments of moderate size, especially if the stomach is empty, it may wound the viscera. But it is in this way only that it has any action when swallowed, and even then its effects are by no means uniformly serious. It can have no chemical action on the stomach; it cannot act through absorption, as it is quite insoluble; and when finely pulverized, it cannot easily wound the villous coat of the alimentary canal, on account of the abundance and viscidity of the lubricating mucus.

Accordingly, *M. Lesauvage* ascertained that 2½ drachms of the powder may be given to a cat at once without hurting the animal,—that in the course of eight days seven ounces might be given to a dog without any bad consequence, although the period chosen for administering it was always some time before meals,—and that even when the glass was in fragments a line in length, no symptoms of irritation were induced. Relying indeed on these results he himself swallowed a considerable number of similar fragments; and did not sustain any injury [*]. —*Caldani* likewise, an Italian physician, after some experiments on animals, gave a boy fifteen years old several drachms of pounded glass, without observing any bad effects; and at his request *Mandruzzato* repeated his experiments on animals, and himself swallowed on two successive days two drachms and a-half each day without sustaining any injury [†].

Similar observations have been made by others also. *Dr W. Turner* of Spanish Town, Jamaica, has informed me, that an attempt was lately made there by a negro to poison a whole family by administering pounded glass; but, although a large quantity was taken by seven persons, none of them suffered any

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[*] Diss. Inaug. Paris, 1810. Analyzed in Sedillot's Journal de Méd. xxxix. 331.

[†] Saggi scient. e litter. dell'Acad. di Padova, T. iii. P. ii. p. 1. quoted in *Marx*, die Lehre von den Giften, I. ii. 196.

inconvenience. Not long ago the occurrence of a simila
at Paris gave rise to a careful investigation of the whole
ject by *Baudelocque* and *Chaussier*.—A young man, Lav
married a girl who was pregnant by him; but it was a
that she should live with her father till her delivery was
A month after the marriage Lavalley invited his wife an
ther-in-law to dinner; and his wife ate heartily boiled
bloody-sausages, and roast-veal, and subsequently drank c
with brandy in it. On returning home in the evening sh
came unwell, continued so all night, next morning was s
with violent pain in the stomach and vomiting, and di
convulsions. The period of her death is not mentioned i
report I have seen. A suspicion of poisoning having a
after burial, the body was disinterred in forty-two days;
although it was much decayed, black points and patches c
be distinguished in many parts of the bowels, with likew
quantity of broken down glass. The medical inspectors acc
ingly declared she had died of poisoning with pounded gl
and the husband was imprisoned. *Baudelocque* and *Chaus*
who were consulted, ascribed the black patches to putrefac
or venous congestion, and declared that, in whatever way
glass had got into the bowels, she had not died of poiso
with that substance, as pounded glass is not deleterious [*].-
similar opinion as to the properties of pounded glass was
lately given by *Professor Marc*, when consulted on a cas
attempted poisoning, where the person against whom the
tempt was made felt the rough particles in his mouth, w
taking the second spoonful of soup in which the glass was c
tained [†].

This opinion certainly appears to be in general true.
the same time instances are not wanting to render it very p
bable, that pounded or broken glass is occasionally hurt
Thus, passing over the more doubtful examples recorded
the older authors, we have the two following cases related
good authorities in the most modern times.—One has b
published by *Mr Hebb* of Worcester. A child, eleven mo
old, died of a few days' illness in very suspicious circums

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[*] *Meyan*, Causes Célèbres. Edit. 2. 1808. T. ii. 324, quoted by *Mar*
Lehre von den Giften, I. ii. 293.

[†] Ann. d'Hyg. Publ. et de Méd. Lég. iii. 365.

ces. On Mr Hebb being requested by the coroner to examine the body, he found the inside of the stomach lined with a tough layer of mucus streaked with blood; the villous coat was highly vascular, and covered with numberless particles of glass of various sizes, some of which simply touched, while others lacerated it; and no other morbid appearance could be detected in the body [*].—The other case is described by *Portal.* A man undertook for a wager to eat his wine-glass, and actually swallowed a part of it. But he was attacked with acute pain in the stomach, and subsequently with convulsions. Portal made him eat a surfeit of cabbage; and having thus enveloped the fragments, administered an emetic, which brought away the glass and vegetables together [†]. The same feat has undoubtedly been sometimes accomplished with impunity. For example, in the Edinburgh Medical and Surgical Journal, an instance is related of a man who champed and swallowed three-fourths of a drinking-glass without suffering any harm; and the person mentioned by Osiander swallowed many pieces of glass, but did not sustain any inconvenience. (P. 597.) But these facts will not altogether outweigh the equally pointed narratives of Portal and Mr Hebb. And, on the whole, the medical jurist must come to the conclusion, that broken and pounded glass, though generally harmless, may sometimes prove injurious or even fatal [‡]. Powdered glass, however, is probably inert.

Another variety of injury from the mechanical irritants is inflammation from hot liquids, such as *Melted Lead or Boiling Water.* These, when swallowed, may unquestionably cause serious mischief, and even death; and the symptoms they induce are exactly those of the irritant poisons properly so called.

The effects of boiling water have been investigated experimentally by *Dr Bretonneau* of Tours; and the results illustrate very forcibly the observations which have been repeatedly made in the course of this work, respecting the slight constitutional derangement caused by such poisons as have merely a local irritating power. He found that when boiling water was injected in the quantity of eight ounces into the stomach of dogs, it excited inflammation, passing on to gangrene, both in the villous and muscular coats. The symptoms, however, were t For a day or two the animals appeared languid; but in days they generally became quite lively and playful, one c actually lined a bitch, and it was only on strangling the examining the bodies, that the extent of the mischief w covered *.

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[*] Midland Medical and Surgical Reporter, i. 47, 1828.

[†] Instruction sur le Traitement des Asphyxiés, &c. p. 118.

[‡] Med. and Surg. Journal, xxii. 233.

I am not aware that any such cases have hitherto oc in man. Death from drinking boiling water, indeed, an uncommon accident, particularly in Ireland and some of England, where children who are in the habit of ing cold water from the tea-kettle swallow boiling wat mistake. It appears, however, that in these instances de not owing to inflammation of the gullet and stomach, l inflammation of the upper part of the windpipe,—the never passing lower than the pharynx. The best and mo cent information on this subject is contained in an inter paper by *Dr Hall* †. He has there given the particulars o cases which came under his notice; from which it follow the disease induced is always *cynanche laryngea*, proving by suffocation. Two of his patients died suffocated; anc while in imminent danger, was relieved by tracheotomy died afterwards of exhaustion; the fourth recovered sud during a fit of screaming, when apparently about to be cho and it was supposed that the vesicles around the glottis had burst by the cries.

Pouring melted lead down the throat was a frequent of despatching criminals and prisoners in former ages. one authentic case is to be found on record of death from cause in modern times. It occurred at the burning of the distone light-house. A man, while gazing up at the fire his mouth open, received a shower of melted lead from building, and expired after twelve days of suffering. S ounces and a-half of lead had reached the stomach; and the mach was severely burnt, and ulcerated ‡.

In concluding the Irritant Poisons, and before proceedi

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[*] Arch. Gén. de Méd. xiii. 372.

[†] London Medico-Chirurgical Transactions, xii. 1.

[‡] Philosophical Transactions, xlix. 477, 483.

the next class, the Narcotics, it is necessary to observe, that besides the substances which have been treated of, there are others not usually considered as poisons, and some that are even used daily for seasoning food, which, nevertheless, when taken in large quantities, will prove injurious, and even occasion all the chief symptoms of the active irritants. These substances connect the true poisons with substances which are inert in regard to the animal economy.

It is impossible to particularize all the articles of the kind now alluded to. But in illustration, I may refer in a few words to five common substances, sulphate of iron, pepper, Epsom salt, alum, and common salt.

It appears from recent experiments by *Professor Gmelin* that the *Sulphate of Iron*, or common green vitriol, when given in the quantity of two drachms to dogs, caused nothing but vomiting,—that forty grains had no effect on rabbits,—and that twenty grains might be injected into the veins of a dog without producing any particular symptom*. It is likewise well known that very large doses of the carbonate of iron have been given to man for the cure of neuralgic diseases without any injury. Yet the experiments of Dr Smith show †, that two drachms of the sulphate of iron will sometimes prove fatal to dogs, either when administered internally, or when applied to a wound; and it has likewise been known to act injuriously on the human subject. In Rust's Magazin, is related the case of a girl, who took as an emmenagogue an ounce of green vitriol dissolved in beer, and was seized in consequence with colic pains, constant vomiting, and purging for seven hours. Mucilaginous and oily drinks soon cured her ‡.—The *Muriate of Iron* is probably a more active compound; but its activity is chiefly owing to the excess of acid, which the preparation of the shops contains. No instance of poisoning with this substance has, so far as I know, been yet published; but the following instructive example has been communicated to me by *Dr Combe* of Leith. A gardener swallowed one morning about an ounce and a half of the tincture of muriate of iron instead of whisky. Violent pain in the throat and stomach, tension and contraction of the epigastrium, and nausea immediately ensued; afterwards, c ness of the skin and feebleness of the pulse were remarked; then vomiting of an inky fluid, with subsequently profuse miting of mucus and blood, and also bloody stools under use of laxatives. For some days he was in a very precar state, but he then began to rally, and in three weeks resu his occupation. In two weeks more, however, Dr Combe fo him emaciated, cadaverous in appearance, and labouring un pains in the stomach, costiveness and thirst; in which stat lingered for five days more, when he died. In the dead b there was found great thickening towards the pylorus,—a c trized patch there three inches long and two inches broad and another large patch of inflammatory redness surrounded a white border. The preparation taken by this person cont a third of its volume of muriatic acid, and a tenth of its wei of oxide of iron, consequently free muriatic acid.

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* Versuche über die Wirkungen, &c.

† *Orfila*, Toxicologie Génerale, i. 609.

‡ Magazin für die gesammte Heilkunde, xxi. 247.

In like manner *Pepper*, which is daily used by all ranks w impunity, will nevertheless cause even dangerous sympt when taken in large quantity. In Rust's Journal is noticed case of a man affected with a tertian ague, who took betw 1½ and two ounces of pepper in brandy, and who was attac with convulsions, burning in the throat and stomach, g thirst, and vomiting of every thing he swallowed. His case treated as one of simple gastritis, and he recovered *.

A very striking instance, which may be arranged under present head, has also been related to me, of apparent pois ing with *Epsom Salt*. A boy ten years old took two oun of this laxative partly dissolved, partly mixed in a teacupful water; and had hardly swallowed it before he was observed stagger and become unwell. When the surgeon saw him an hour after, the pulse was imperceptible, the breathing s and difficult, the whole frame in a state of extreme debili and in ten minutes more the child died without any other sy tom of note, and in particular without any vomiting. The cumstances having been investigated judicially, it appeared the substance taken was pure Epsom salt; that the father, was doatingly fond of the child, gave the laxative on acco of a trifling illness which he supposed might arise from wor and that on the most careful inspection of the body, no mor appearance whatsoever could be found in any part of it. For the particulars of this singular case, I am indebted to *Dr Dewar* of Dunfermline, the medical inspector under the Sheriff's warrant. It shows that in certain circumstances even the laxative neutral salts may be irritating enough to cause speedy death.

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* Magazin für die gesammte Heilkunde, xxi. 549.

Another still more striking instance of this kind of poisoning occurred in London in September 1828. A man, who had been in the custom of exhibiting various feats of gluttony, proposed to some of his comrades one afternoon to sup a pound of *Common Salt* in a pint of ale, and actually finished his nauseous dish, but not without being warned of his imprudence by an attack of vomiting in the middle of it. He was soon after seized with all the symptoms of irritant poisoning, and died within twenty-four hours. The stomach and intestines were found after death excessively inflamed *.

In France, though not hitherto, so far as I know, in Britain, several instances have occurred of extensive sickness in particular districts, which have been traced to the accidental adulteration of *Common Salt* with certain deleterious articles. In an investigation conducted by *M. Guibourt* in consequence of several severe accidents having been produced apparently by salt in Paris and at Meaux, oxide of arsenic was detected †; and this discovery was subsequently confirmed by *MM. Latour and Lefrançois*, who ascertained that the proportion of arsenic was sometimes a quarter of a grain per ounce ‡. Another singular adulteration which appears fully more frequent is with hydriodate of soda. At a meeting of the Parisian Academy of Medicine in December 1829, a report was read by *MM. Boulay* and *Delens* subsequent to an inquiry by *M. Sérullas* into the nature of a sample of salt which appears to have occasioned very extensive ravages. In 1829, various epidemic sicknesses in certain parishes were suspected to have arisen from salt of bad quality. In the month of July no less than 150 persons in two parishes were attacked, some with pain in the stomach, nausea, slimy and even bloody purging, others with tension of the belly, puffiness of the face, inflammation of the eyes and swelling of the legs; and in several parishes in the

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* London Courier, Oct. 1, 1828.

† Journal de Chim. Méd. vi. 265.

‡ Ibidem, vi. 458.

Department of the Marne a sixth part of the population w
similarly affected. The salt being suspected to be the soı
of the mischief, as it had an unusual smell which some comı
ed to the effluvia of marshy ground, M. Sérullas analyzed
and after him MM. Boullay and Delens; and both analyses
dicated the presence of a hundredth of its weight of hydrioc
of soda, besides a little free iodine [*]. Subsequently, in r
rence to the discovery by other chemists of arsenic in differ
samples of suspected salt, M. Sérullas repeated his analysis,
could detect none of that poison [†]. Still more lately the wh
subject has been investigated with great care by *M. Chevallie*
M. Barruel states that he observed the occasional adulterati
of salt with some hydriodate accidentally in 1824, while p
paring experiments for Professor Orfila's Lectures. He fou
it in two samples from different grocers' shops in Paris [§].—
satisfactory explanation has yet been given of the source of t
adulteration with arsenic; but the presence of hydriodate of so
has been traced, as already stated [p. 185], to the fraudulent ı
of impure salt from kelp.

Some difference of opinion prevails among toxicologists
regard to the alleged deleterious qualities of *Alum*. On the who
it scarcely appears so active as to deserve the name of a poiso
yet, like other salts, it may in large doses do serious injury.
merits particular mention among the present description of su
stances, partly on account of a trial at Paris, where dangero
effects were alleged to have been produced by it, and partly f
the physiological inquiries made on that occasion. A druggi
supplied a lady by mistake with powder of burnt alum inste
of gum-arabic; and the lady, who had long laboured und
chronic derangement of the stomach and bowels, took a sing
dose of a solution containing between ten and twenty grains
the salt. She immediately complained of acute pain in the st
mach and gullet, burning in the mouth, and nausea; the symı
toms of a severe attack of inflammation in the stomach a
bowels ensued; and she was not considered out of danger f
several days. The druggist was accordingly prosecuted, a

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[*] Archives Gén. de Méd. xxi. 616, or Journ. de Chim. Méd. v. 621 and vi.

[†] Journal de Pharmacie, xvi. 322, or Journ. de Chim. Méd. vi. 263.

[‡] Annales d'Hyg. Publique et de Méd. Légale, viii. 25.

[§] Journal de Chim. Méd. iv. 275.

heavy damages claimed. The attending physician ascribed the symptoms to the alum. But *Marc* and *Orfila*, who were consulted, declared that this was impossible except on the supposition that the lady had a very unusual sensibility of the stomach to irritating substances;—that it was a common thing to give three, four, and even five times the quantity in the treatment of diseases, without any such consequences resulting;—and that at the very time of the inquiry a physician in Paris was using it to the amount of six or eight drachms in the day. From an experimental inquiry conducted by Professor Orfila it appears, that large doses of calcined alum, such as one or even two ounces, excite in dogs little more than one or two attacks of vomiting, even although retained between ten and thirty minutes,—that one ounce will not excite any marked symptoms though secured in the stomach by a ligature,—but that two ounces given in the same way prove fatal in five hours, under symptoms of excessive exhaustion and insensibility [*]. A similar inquiry was instituted about the same time by *M. Devergie*, who seems however to have remarked more activity in alum than is indicated by Orfila's experiments. He infers that two ounces may sometimes kill dogs, even though they vomit freely; that half that quantity is fatal if the gullet be tied; that calcined alum is more active than a solution of the salt; that it is a corrosive or irritant; and that probably man is more sensible to its operation than the lower animals [†]. Whatever may be thought of the effects of alum on the animal body when administered in large doses, it is plain from its frequent medicinal use as an internal astringent that it is not poisonous when given in small doses, like that taken by the patient in the trial alluded to. I may add that it appears very doubtful whether any injury accrues from the long-continued use of very small doses. Bakers, it is well known, are in the practice of using it in minute proportion for improving the whiteness of bread; and it has been imagined that chronic disorders of the stomach and bowels may consequently originate by reason of its constipating tendency. These fears, however, are not borne out by any pointed facts. Either the quantity is insufficient to do harm in the way supposed, or the constitution becomes accustomed to the continual operation of the salt, and does not suffer.

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[*] Annales d'Hyg. Publique et de Méd. Légale, i. 235.

[†] Dictionnaire de Méd. et Chirurg. Pratiques, v. 124.

CHAPTER XXVI.

CLASS SECOND.

OF NARCOTIC POISONS GENERALLY.

The term Narcotism has been used by different writers wi different significations, but is now generally understood to c note the effects of such poisons as bring on a state of the syst like that caused by apoplexy, epilepsy, tetanus, and other d orders commonly called nervous. Narcotic poisons, therefo are such as produce chiefly or solely symptoms of a disorder the nervous system.

The mode in which most of the narcotic poisons act has be well ascertained: They act on the brain or spine or both l entering the blood-vessels. Hence they are most active wh most directly introduced into the blood, that is, when inject into the veins; and when they are applied to an entire me branous surface, their energy is in the ratio of its absorbi power. Thus, when injected into the chest, they act more r pidly than when swallowed. According to the generally r ceived opinion, they are conveyed with the blood to the bra and spine on which they act. But, according to the expe ments of *Messrs Morgan* and *Addison*, they produce on t inner coats of the blood-vessels a peculiar impression, whi is conveyed to the centre of the nervous system along t nerves.

The usual symptoms in man and the higher orders of anima are giddiness, headach, obscurity or depravation of the sigh stupor or perfect insensibility, palsy of the voluntary muscles c convulsions of various kinds, and towards the close comple coma. The symptoms of each poison are pretty uniform, wh the dose is the same. But each has its own peculiarities, eith in the individual symptoms, or in the mode in which they a combined together.

The morbid appearances they leave in the dead body a commonly insignificant. In the brain, where chiefly the ph sician is led from the symptoms to expect unnatural appear ces, the organs are in general quite healthy. Sometimes, however, the veins are much gorged with blood, and the ventricles and membranes contain serosity. The blood appears to be sometimes altered in nature; but these changes are by no means invariable, and are sometimes not remarked at all. Many of the statements to be found in authors on the morbid appearances caused by the narcotics are far from being accurate.

Before proceeding to notice the genera of this class in their order, some remarks must be premised on the principal diseases which resemble them in the symptoms and morbid appearances. Of these the only diseases of much consequence are *Apoplexy*, *Epilepsy*, *Inflammation of the Brain*, *Hypertrophy of the Brain*, *Inflammation of the Spinal Chord, and Syncopal Asphyxia.*

Of the Distinction between Apoplexy and Narcotic Poisoning.

Of the Symptoms.—The symptoms of apoplexy are almost exactly the same as those of the narcotic poisons, namely, more or less complete abolition of sense and the power of motion, frequently combined with convulsions. This disease commonly arises from congestion or effusion of blood within the skull; but one variety of it, the nervous apoplexy of older authors, or Simple Apoplexy of the moderns, is believed to be an affection of the brain, unaccompanied by any recognizable sign of deranged structure.

Apoplexy and narcotic poisoning may be often distinguished by the following criterions:

1. Apoplexy is sometimes preceded at considerable intervals by warning symptoms, such as giddiness, headach, ringing in the ears, depraved vision, or partial palsy. But it is an error to suppose that warning symptoms always occur: nay, if we may trust the experience of *M. Rochoux*, one of the best of the recent writers on apoplexy, they are by no means common: Of sixty-three cases which came under his notice nine only had distinct precursory symptoms *. Poisoning with the narcotics of course has not any precursory symptom except by fortuitous combination. And consequently, if warning symptoms have occurred, the presumption is, that the cause of death is a natural one.

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* Recherches sur l'Apoplexie, p. 70.

2. Apoplexy attacks chiefly the old. It is not, however, co fined to the old. On the trial of Captain Donnellan for p soning Sir T. Boughton, *Mr John Hunter* mentioned that h had met with two instances of death from apoplexy in youn women; my colleague Dr Alison has related to me a simil case; *Professor Bernt* has related another of a young girl wh died apoplectic from extravasation of blood over the whol brain and in the ventricles also [*]; and *Mr Greenhow*, a surgeo of London, has even noticed a case of apoplexy from effusio of blood over the surface of the brain in a child two years an a half old [†]. On this subject the treatise of *Rochoux* supplie excellent information: Of his sixty-three cases sixty-one wer above thirty years of age, two less than thirty, none younge than twenty [‡]. It is plain, therefore, that apoplexy in youn people is rare. On the other hand, a great proportion of case of poisoning with the narcotics, when they have been taken intentionally, (and such cases are most likely to lead to medico-legal questions,) has occurred among the young, especially o the female sex.

3. The next criterion is, that apoplexy occurs chiefly among fat people. But it is here mentioned only that the medical jurist may be cautioned against the belief that it is in all circumstances a correct criterion. Upon this particular *Rochoux* has furnished some satisfactory data. Among his sixty-three patients thirty were of an ordinary habit, twenty-three were of a thin, meager habit, and ten only were large, plethoric, and fat [§]. In receiving this statement, however, it is necessary to consider, that although the vulgar idea, that most apoplectic people are fat, does not apply to persons in the rank of Rochoux's patients, who were mostly hospital patients, yet it will apply better to the middling ranks. For the same circumstances which predispose to apoplexy, namely, great strength, vigorous constitution, and good digestive powers, likewise predispose to corpulency, so that whenever the condition of life permits the tendency to corpulency to be developed, the connexion of apoplexy with it will appear.

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[*] Beiträge zur Gerichtlichen Arzneikunde, iii. 40.

[†] London Medical and Physical Journal, xlvii. 181.

[‡] Recherches sur l'Apoplexie, 212.

[§] Ibidem, p. 214.

4. A fourth criterion is drawn from the relation which the appearance of the symptoms bears to the last article of food or drink that was taken. I believe that the effects of the common narcotics, in the cases where they prove fatal, begin not later than an hour or at the utmost two hours after they are taken; and in a great majority of instances they begin in a much shorter time, namely, in fifteen or thirty minutes. Hence if it can be proved that the nervous symptoms, under which a person died, did not begin till several hours after he took food, drink, or medicine, it appears almost, if not absolutely certain, that a narcotic poison cannot have been the cause of death. To some narcotic, or rather narcotico-acrid poisons this rule certainly will not apply, such as the Poisonous Fungi and Spurred Rye; which seldom begin to act for several hours, sometimes for not less than a day and a half. Neither will the rule apply to poisoning with the deleterious gases, as their action has no connexion at all with eating or drinking. But I do not consider that these facts form a material objection to the rule laid down, because the circumstances under which cases of the kind occur are generally so apparent as at once to point out their real nature to a careful inquirer.

In regard to apoplexy as the disease which resembles most closely the effects of the narcotics, it was formerly stated that this disease is apt to occur soon or immediately after taking a meal. (p. 103.)* In the greater number of such cases, however, where the meal has been the exciting cause of the disease, the symptoms have begun *immediately* after or even during a meal. This is very rarely the case with the symptoms of narcotic poisoning, and never happens in respect to those of the commonest of the narcotics, opium: An interval of 10, 15, 20 or 30 minutes always occurs. The deleterious gases and hydrocyanic acid, with its compounds, are the only familiar narcotic poisons which act more swiftly.

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* Instances of congestive apoplexy thus arising were then quoted. I may here add a very apposite instance of hemorrhagic apoplexy, occurring in similar circumstances, which has come under my notice since the former sheets were printed. *Dr Jennings*, an American physician, mentions a case where a female of fifty, after a full meal, tumbled down in a fit of insensibility and immediately expired, and where after death there was found enormous distension of the stomach with food, an extensive extravasation of blood into the central parts of the brain, and the cerebral arteries ossified. (London Med. Gazette, xvi. 735.)

5. Another criterion relates to the progress of the symptom The symptoms of narcotic poisoning advance for the most pa gradually; but those of apoplexy in general begin abruptly. Sometimes apoplexy commences at once with deep sopor. Narcotic poisoning never begins in that way, except i the instances of hydrocyanic acid and the narcotic gases; th sopor is at first imperfect, and it increases gradually, thoug sometimes very rapidly. Apoplexy, however, does not alway begin with deep sopor; occasionally the sopor begins and increases like that of narcotism.

6. Although there is a great resemblance between the symptoms of apoplexy and those of narcotism, so far as regards their general features, there are particulars which are not indeed always present, but which when present will help to distinguish the one from the other. When the sopor of apoplexy is completely formed, it is rarely possible to rouse the patient to consciousness, and never, I believe, where the risk of confounding apoplexy with poisoning is greatest,—in the cases where death happens neither instantly, nor after the interval of a day, but in a few hours. On the other hand, in many cases of poisoning with the narcotics, and particularly with the commonest variety, opium, the person may be roused from the deepest lethargy, if he is spoken to in a loud voice, or forcibly shaken for some time, or if water is injected into his ear. Even in cases of poisoning with opium, however, the coma may have continued too long to admit of this temporary restoration to sense; the susceptibility of being roused is not so often remarked in other varieties of narcotic poisoning; and in some, such as poisoning with prussic acid, I am not aware that it has ever been remarked, at least in fatal cases.

There are some other symptoms which in special cases may help to distinguish narcotic poisoning from apoplexy. Thus in poisoning with opium convulsions are rare; in apoplexy they are common enough. Bloating of the countenance is likewise much more common in apoplexy than in poisoning with opium. In apoplexy, too, the pupil is generally dilated, while in poisoning with opium the pupil is much more frequently contracted. But such distinctions do not apply either to the narcotics as a class, or to all cases of any one kind of narcotic poisoning.

7. In the last place, a useful criterion may be derived from

the duration of the symptoms in fatal cases. I believe few people die of pure narcotic poisoning who outlive twelve hours; and the greater number die much sooner,—in eight, or six hours. Apoplexy very often lasts a whole day, or even longer. —On the other hand, the narcotic poisons very rarely prove so rapidly fatal as apoplexy sometimes does. Apoplexy, according to the common opinion, may prove fatal instantly or in a few minutes. The best modern pathologists, however, deny this, and maintain with much apparent reason that when death is so sudden, the cause is commonly disease of the heart, and never apoplexy [*]. But although that disorder cannot prove instantaneously fatal, it may decidedly occasion death in considerably less than an hour. The only narcotics in common use which can prove fatal so soon are the narcotic gases, and prussic acid. As to opium, the most common of the narcotic poisons, and by far the most important to the medical jurist, the shortest duration I have yet seen recorded is three hours. Apoplexy often proves fatal in a much shorter time.

From this enumeration of the criterions between apoplexy and the symptoms produced by the narcotics, the toxicologist will conclude, that few cases can occur in which he will not be able to give a presumptive opinion of the real cause from the symptoms only,—that in many instances a diagnosis may be drawn with an approach to certainty,—and that on all occasions it will be possible to say without risk of error, whether there are materials for drawing a diagnosis at all,—a point which is of great moment when the criterions are not universally applicable.

Of the Morbid Appearances.—The next subject of inquiry is the distinction between apoplexy and narcotic poisoning, as to the appearances after death. It has been already stated, that the narcotic poisons rarely produce very distinct morbid appearances,—that the greatest extent of unnatural appearance they cause in the brain is congestion of vessels,—and that the physical qualities of the blood appear to be altered, though not invariably.

Of Simple Apoplexy.—Apoplexy may, in the first place, occasion death without leaving any sign at all in the dead body. Cases of this sort were called nervous apoplexy by the older authors; but for the purpose of avoiding a name that involv a theory as to their nature, they have been of late more appr priately termed by *Dr Abercrombie* Simple Apoplexy. At on time they were believed to be common. The researches modern pathologists, however, have shown that they are rar and that the apparent absence of morbid appearances may b often with justice ascribed to an insufficient examination; as i is not always easy to detect, without minute attention, two dis orders little known till in recent times, and sometimes close ly allied in their symptoms to apoplexy,—hypertrophy of th brain, and inflammation of its substance. On this account som have even gone so far as to deny altogether the existence o simple or nervous apoplexy; and *M. Rostan*, who is of thi opinion, has supported it by the fact, that in the course of hi pathological researches he had examined no less than 4000 heads, and never met with an instance of it *. But although this statement, made by so eminent a pathologist, is sufficient to prove the rarity of the disease, it does not establish its non-existence in the face of positive observations, made by others after the phenomena and effects of cerebral inflammation were well known.

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[*] *Rochoux,* Recherches sur l'Apoplexie, 66.

Among the modern authorities to whom reference may here be made for examples of Simple Apoplexy, *Dr Abercrombie*, *M. Louis*, my colleague *Dr Alison*, and *M. Lobstein*, may be particularized. Dr Abercrombie has seen four cases †, M. Louis has recorded three ‡, M. Lobstein one §, and Dr Alison informs me, that he has seen one and got the particulars of another from the late Dr Gregory. In several of these cases the individuals were at the time of the apoplectic seizure affected with other diseases, such as asthma, anasarca, or slight febrile symptoms; but in four of them the coma commenced during a state of perfect health. I have myself seen two of the former class, one occurring during convalescence from a slight pleurisy, the other terminating a complicated case of pulmonary emphysema and catarrh, diseased kidneys and anasarca. Reference may be also made under this head to several cases of remembered, that congestion of the cerebral vessels is considered by many a common effect of such poisons, and that, therefore, the diagnosis cannot be rested on the appearances in the dead body. I have not perused a sufficient number of fatal cases of congestive apoplexy to enable me to attempt a diagnosis; but, so far as I have gone, it appears to me, that this form of the disease, which is not often fatal without extravasation also being produced, never causes death but after an interval of nearly a day at least. Should this prove a general fact, it would form the ground of a diagnosis between Congestive Apoplexy and many forms of narcotic poisoning, which, if death ensues, prove fatal much sooner.

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* Recherches sur le Ramollissement du Cerveau, p. 150.

† Pathological and Practical Researches on Diseases of the Brain, p. 210.

‡ Recherches Pathologiques, 460, 466, and 472.

§ Archives Gén. de Méd. xxiii. 260.

Of Serous Apoplexy.—Apoplexy may, in the third place, produce serous effusion on the external surface, and in the ventricles of the brain. This form of the disease has been named Serous Apoplexy, and is not very uncommon as an insulated affection, but is for the most part united with inflammation of the cerebral substance. Serous effusion is more frequently the termination of an inflammatory disorder of the brain, than of that deranged state which constitutes the apoplectic attack. But nevertheless it does occur in connexion with pure apoplexy, as may be seen, for example, on referring to Dr Abercrombie's work *, or to *Bernt's* Contributions to Medical Jurisprudence †, or to the Hospital Reports of *Dr Bright* ‡. In such cases the only appearances have been the effusion of an unusual quantity of serum on the surface of the brain, in its ventricles, and in the base of the skull. Cases of this sort agree very exactly as to the signs in the dead body with some cases of narcotic poisoning. When serous effusion is preceded by decided apoplectic symptoms, the disease, so far as I have been hitherto able to inquire, is always of several days' duration. But sometimes the symptoms are to the very last obscure and different from those of apoplexy, as in an instance related by Dr Abercrombie §.

Of Apoplexy from extravasation.—The last variety of apoplexy is that which leaves in the dead body extravasation of blood within the head. This, the most common of all its for is very rarely imitated by narcotic poisoning. A case, h ever, will be afterwards mentioned of extravasation produ apparently by poisoning with opium, another of extravasat caused by carbonic acid, another by a poisonous fungus, several by spirits. The existence, therefore, of extravasa blood is not absolutely certain proof, but supplies, in relat to most narcotics, a very strong presumption, of natural de

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* Pathological Researches, 214.

† Beiträge zur gerichtl. Arzneik. ii. 61. iii. 42. iv. 42.

‡ Reports of Medical Cases, ii. 240, 242, 244.

§ Pathological Researches, 216.

Here it will be necessary to add a word or two of caut regarding what are called apoplectic cells, or cavities conta ing blood in the brain. If an apoplectic cell be found, it m not be at once considered as the cause of death. When bl is extravasated in the brain, the patient may gradually reco altogether, and the cell nevertheless continue full. Such p sons generally die of a subsequent attack of apoplexy, or of flammation around the cell. We can say with certainty t an apoplectic cell has been the occasion of death only when blood is recent, or when it is surrounded by the signs of rec inflammation.

So much, then, as to the criterions derived from the mor appearances within the skull, for distinguishing poisoning wi narcotics from apoplexy.

It has been proposed to derive other criterions from the st of the blood. But on considering the effects of the individu poisons of the class, it will appear that the state of the blood by no means characteristic.

Of the Distinction between Epilepsy and Narcotic Poisoning.

Of the Symptoms.—Epilepsy is distinguished from other di eases by the abolition of sense and by convulsions. It resem bles closely the symptoms caused by prussic acid, and by son of the narcotic gases, such as carbonic acid gas and the asphy iating gas of privies. It also bears the same resemblance the effects of many narcotico-acrid poisons, such as belladon stramonium, hemlock, and others of the first groupe of th class, also camphor, cocculus indicus, and the poisonous fun

Epilepsy is in general a chronic disease, and for the mo part ends slowly in insanity. But sometimes it proves fa during a paroxysm. The circumstances by which an epilep fit may be distinguished from narcotic poisoning are the following:

1. The epileptic fit *is sometimes preceded by certain warnings*, such as stupor, a sense of coldness, or creeping, or of a gentle breeze proceeding from a particular part of the body towards the head. Warnings, however, are by no means universal. *M. Georget*, indeed, has even stated that they do not occur in more than five cases in the hundred [*]. But this estimate probably underrates their frequency.

2. The symptoms of the epileptic fit *almost always begin violently and abruptly.* The individual is suddenly observed to cry out, often to vomit, and instantly falls down in convulsions. The effects of the narcotic poisons, if we except some cases of poisoning with hydrocyanic acid, the narcotic gases, and a few rare alkaloids, never begin otherwise than gradually, though their progress towards their extreme of violence is often rapid. This distinction is generally an excellent one. But it will not apply so well to some cases of epilepsy in which the convulsions are trivial. *Esquirol* says an epileptic fit may consist of nothing more than coma, with convulsive movements of the eyes, or lips, or chest, or a single finger [†]. Still even then the coma generally begins abruptly, so that if the case is seen from the beginning, it can hardly be mistaken for narcotic poisoning. Some forms of epilepsy, in which the fit is constituted merely by giddiness, staring, wandering of the mind, and imperfect loss of recollection [‡], might be confounded with the milder forms of narcotic poisoning. But collateral circumstances will scarcely ever be wanting to distinguish such cases from one another.

The varieties of narcotic poisoning which, in the violence and abruptness of their commencement, bear the closest resemblance to an epileptic attack, are some cases of poisoning with hydrocyanic acid or with the deleterious gases. Both of these varieties, however, when they begin so abruptly, are distinguished from a fatal paroxysm of epilepsy by the fourth characteristic to be mentioned presently; and besides, in abrupt cases of poisoning with hydrocyanic acid, the poison under certain conditions will be found in the body; while in sudden

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[*] Article *Epilepsie* in Dictionnaire de Médecine, viii. 209.

[†] Ibidem, xii. 512.

[‡] Georget, *in loco cit.* 212.

poisoning with the narcotic gases, the nature of the accide
rendered obvious to a cautious inquirer by the collateral cir
stances.

3. As in apoplexy, so in epilepsy the patient *in general ca*
be roused by external stimuli. This, as already observed, is o
although certainly not always, practicable in cases of poiso
with the narcotics. Sometimes, too, in the epileptic fit a
tial restoration of consciousness may be effected by loud sp
ing, so that in reply to questions the patient will roll his
or move his lips. It is therefore to be understood in appl
the present criterion, that it is only a safe guide when, a
many cases of poisoning with opium, the individual can be r
ed to a state of tolerably perfect consciousness.

4. When a person dies in a fit of epilepsy, *the paroxysm*
nerally lasts long, sometimes more than a day. So far as I h
been able to ascertain, (though on this point it must be con
sed authors are singularly silent), it never proves fatal i
shorter time than several hours, unless there have been m
previous fits; and even then it very rarely proves fatal m
rapidly. I have met with a case which, after many previ
fits, proved fatal in little more than an hour [*]. In an insta
mentioned by *Mr Clifton* of irregularly recurring epilepsy,
patient after being exempt for four months was attacked tw
a-day for four days, and during an interval of ease fell dowr
the street and died. General congestion and excessive s
ening of the brain were found [†]. I have met with a case v
like this, where death was owing to enormous extravasatio
blood into the ventricles. So rapid a termination never occ
except after several paroxysms; and probably never with
well-marked appearances in the dead body. The variety
poisoning with which epilepsy is most apt to be confounded, p
soning with hydrocyanic acid, has hitherto always proved fa
within three quarters of an hour, and can probably never pr
fatal so late as a whole hour after the symptoms begin, un
the dose has been small and given repeatedly. Poisoning w
the gas of privies,—another variety, which sometimes imit
precisely a fit of epilepsy, appears not to prove fatal in its c
vulsive form later than two hours after the exposure.

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[*] The body in this case was not examined.

[†] Edin. Med. and Surg. Journal, x. 40.

5. *M. Esquirol*, a writer of very high authority, says that epilepsy *very rarely proves fatal in the first paroxysm.* I suspect it may be said that the first paroxysm never proves fatal. For the cases considered and described as such have been either inflammation of the brain or its membranes, or hypertrophy of the brain, or inflammation of the spinal chord, or effusion of serum or blood into the spinal canal,—all of which may be known by the morbid appearances. I have also seen cases of continued fever with typhomania and convulsions, which might have been considered by a careless observer examples of epilepsy fatal in the first fit. On the present characteristic it would be wrong to speak with confidence, as the question regarding the possible fatality of epilepsy in the first fit must depend greatly on the degree of extension given to the term epilepsy. I can only say, that in the course of reading I have not hitherto met with an instance fatal in the first paroxysm, which might not have been referred by the morbid appearances to one or other of the diseases mentioned above.

Of the Morbid Appearances.—With regard to the morbid appearances found in the bodies of epileptics, much difference of opinion prevails among pathologists. The most frequent appearances are tumours within the cranium, excrescences from the bone or dura mater, concretions in the brain itself, or abscesses there, and effusion into the ventricles or on the surface of the brain. Other appearances which have also been remarked are probably little connected with the disease; and at all events have been often seen when epilepsy did not precede death [*].

The morbid appearances connected with epilepsy are not always to be looked for within the head. The cause which produces the fit is often some irritation in distant organs.—The presence of worms in the intestines of children may occasion fatal epilepsy. It is believed also that they may cause fatal epilepsy even in adults; and whether their presence has been the cause of death or not, it is certain that they have often been found enormously accumulated in the stomach or intestines of adult epileptic subjects [†]. The most recent information on this subject is furnished by *M. Gaultier de Claubry.* In a girl seven years old, who died of convulsions in six days, he found elev *lumbrici* in the general cavity of the belly, and the coats of t stomach perforated with holes, in some of which other wor were sticking. In another child of the same age, who died seven days of convulsions, he found thirty-six worms in t peritonæal sac, a great mass of them in the stomach, and twe ty-seven making their way through holes in its coats [*]. Ir very singular case related by *M. Lepelletier* of a boy twel years old, who died of convulsions in four days, the only mo bid appearance found was a perforation of the gullet six lin in diameter, through which two lumbrici had made their w into a cavity in the middle right lobe of the lungs, while an ther was sticking in the hole, six more occupied the lower pa of the gullet, and three lay in the stomach [†].—The irritation teething may also excite epilepsy, and in cases where it h proved fatal may be recognized by the redness and swelling the gum, by the tooth being on the point of piercing the alve lar process, and by the turgescence of vessels around [‡].—A ve well known but rather rare cause is the presence of some ha substance in the course of a nerve. This variety, like tho already mentioned, may prove fatal in the fit, as appears fro the following interesting case. A stout young woman becan suddenly liable to epilepsy, and, after having repeated fits the course of twenty months, died comatose in a paroxysm thirty-three hours' duration. The fits having always beg with acute pain in a particular part of the thigh, this part of t body was carefully examined, and a bony tumour as big as nut was found on a branch of the sciatic nerve [§].—Other a pearances might likewise be here enumerated, which have bee supposed the causes of symptomatic epilepsy [‖]. But few these have been so thoroughly ascertained as to be allowed muc influence on a medico-legal opinion.

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[*] *Esquirol*, Dict. des Sciences Méd. xii. 528.

[†] *Corvisart's* Journ. de Méd. xiii. 315, and xl. 81; also *Prost*, la Médecine éclairée par l'ouverture des cadavres, ii. 382, 389, 394.

It cannot, I apprehend, be denied, that in many cases of ep lepsy no decided morbid appearance is to be found in the body and that in many others the appearances are either so equivoc as not to be satisfactorily recognized in any circumstances, or so hidden in their situation that they may escape notice, unless the inspector's attention be drawn to the particular spot by a knowledge of the symptoms.

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[*] Nouveau Journal de Médecine, ii. 269.

[†] Journal Hebdomadaire et Universel, iv. 366.

[‡] *Portal*, Observations sur la nature et le traitement de l'Epilepsie, p. 65 and

[§] Memorie della Soc. Méd. di Genova, i. 89.

[‖] *Portal*, passim.

Hence in actual questions as to the occurrence of narcotic poisoning when the symptoms resemble epilepsy, it will be seldom possible to found on the absence of morbid appearances more than a presumptive opinion that death did not proceed from the natural cause. It is right to remember, however, that in considering the absence of morbid appearances in reference to the diagnosis of narcotic poisoning and epilepsy, the attention should be confined to cases of epilepsy which prove fatal during the fit. Now I suspect no such case ever occurs, at least in adults, without an adequate cause being discoverable in the dead body, either in the head, or in the course of some nerve, or in the accumulation of worms in the intestines. This statement must not be considered as made with confidence; but it deserves investigation.

From all that has now been said on the subject of epilepsy as a disease which imitates many varieties of narcotic poisoning, the medical jurist will probably arrive at the conclusion, that, although a diagnosis cannot always be drawn with certainty, yet in numerous cases the consideration of the symptoms and appearances after death will enable him to say positively that poisoning is out of the question, and in many others that poisoning is highly probable.

Of the Distinction between Meningitis and Narcotic Poisoning.

Inflammation of the inner membranes of the brain, which constitutes the *Acute Hydrocephalus* or acute *Meningitis* of authors, is not in general apt to cause much ambiguity; for its progress is commonly gradual, well-marked and less rapid than most cases of narcotic poisoning; and the appearances in the dead body, such as effusion of serum, lymph or pus on the outer surface of the brain or in the ventricles, are for the most part obvious.

Dr Abercrombie, however, has described a form of it occurring among children during the existence of other diseases, particularly of the chest, which might be the cause of perplexity; for its course is sometimes terminated within a day, its symptoms are delirium, convulsions and coma intermingled, and only morbid appearance is congestion of vessels on the surf and in the substance of the brain *. The affection now allu ed to imitates very closely, both in its progress and in its sig after death, some varieties of poisoning with the vegetable na cotico-acrids, such as belladonna, stramonium, and hemlo But the latter cases, when they prove fatal, seldom last nea so long as a day, while the instances of meningitis under co sideration rarely cause death within twenty-four hours. Abercrombie also notices a parallel disease occurring amo adults; but it is in them always marked by a considerab longer, though often more obscure course †.

Dr Bright takes notice of a similar affection under the ti of " Arachnitis with excessive irritability" occurring chie among very intemperate people, but independently of previo disease. In general the disorder has a well-marked course at least several days' duration. But in two of the instances l has given the early stage was very obscure, the only sympton having been headach and sickness of no great severity for fo or five days; after which delirium came suddenly on, and w followed by coma, and by death within thirty-six or forty hour The sole appearances found within the head were some serou effusion and vascularity on the surface of the brain and in th ventricles ‡. To these illustrations may be added the heads c a very remarkable case, which lately occurred here in the per son of an eminent lawyer, and for the particulars of which am indebted to *Dr Maclagan*. For three days there had bee occasional headach, not great enough to prevent him pursuin his ordinary avocations, yet becoming so troublesome on th morning of the third day as to induce him to have leeches applied But next morning he was seized rather suddenly with quickl increasing coma, and in forty hours more he expired. In thi instance the whole surface of the arachnoid membrane, both over the hemispheres and in the ventricles, was found line with soft, yellowish-green lymph.

In such cases it is apparent that an inspection after deat will often unfold their real nature where the history of th symptoms may leave it in doubt. But even without an inspection it is not likely that a careful physician could mistake them for narcotic poisoning; for independently of other considerations there is always, before the severe symptoms set in, a precursory stage of ill health, commonly indicating an obscure affection of the head, and such as no one but a very careless observer could fail to discover and appreciate.

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* On Diseases of the Brain and Spine, Cases, 18, 19, 20.

† On Chronic Inflammation of the Brain. Ed. Med. and Surg. Journ. xiv.

‡ Reports of Medical Cases, ii. 14, 15.

I should scarcely have thought it necessary to mention *Chronic Meningitis* among the diseases apt to imitate the effects of narcotic poisons, because it is commonly marked by a long and distinct course. But the following case, for which I am indebted to *Dr Arnoldi* of Montreal, lately one of my pupils, will show that, like other diseases of the head, chronic meningitis may be latent in its early stage, and may, after developing itself, terminate in a day, and then in some measure imitate poisoning with narcotics. A middle-aged female, subject for a twelvemonth to a purulent discharge from the left ear, and occasional headach, which was supposed to be rheumatic, was seized one morning with acute pain in the head, followed in a few hours by convulsions and tendency to coma; under which symptoms she died within twenty hours, although treated actively from the commencement. On dissection, the brain and pia mater were found healthy, except at the part corresponding with the petrous portion of the left temporal bone, where the brain was a little softened. The corresponding part of the temporal bone and the adjacent part of the occipital were completely denuded and covered with pus, which had established a passage for itself into the cavity of the ear.

Of the Distinction between Inflammation of the Brain and Narcotic Poisoning.

Inflammation of the Brain itself, the *Ramollissement* of French writers, occasionally excites symptoms not unlike those produced by some narcotic poisons; and in a few instances its course has appeared to be equally short. It requires particular notice, because the appearances left in the dead body are sometimes apt to escape observation.

This disease in its well-marked form has been noticed by various authors from Morgagni downwards. But the first regular accounts of it were given in 1818 by *Dr Abercrombie*[*] and in 1819 by *M. Rostan*[†] of Paris, and *Professor Lallemand*[‡] of Montpellier. Its symptoms are allied to those of apoplexy and epilepsy. But the comatose state is generally preceded by delirium or imperfect palsy, and often by a febrile state of the circulation. Contraction of the voluntary muscles, which was once supposed to be a distinguishing sign of this disease, is neither essential nor peculiar to it. In the dead body it is recognized by the presence either of an abscess in the brain,—or more commonly of a nucleus of disorganized cerebral tissue surrounded by unnatural redness or softness,—or sometimes of a clot of blood surrounded by similar softening. Occasionally, when the disease kills in its early stage, nothing is found but redness of a part of the brain, and slight softening of the tissue, recognizable only by scraping it with the edge of the scalpel.

In the form in which it is commonly seen, and as described by Rostan and Lallemand from a great number of cases, it can hardly be confounded with the effects of Narcotic Poisons, as its course is much slower. It seldom proves fatal in less than several days[§]. Yet in some instances it may prove fatal instantly. *Lancisi* notices the case of an Italian nobleman, who after an apoplectic fit became liable to frequent but slight attacks of lethargy,—who at length died quite suddenly more than a year afterwards,—and in whose brain an organized clot was found, with extensive suppuration of the brain around it[‖]. An unequivocal case of the same kind has been related by *Mr Dickson*, a navy-surgeon. An elderly sailor, who for months before had done duty, eaten his rations, and drunk his grog as usual, suddenly dropped down while in the act of pulling his oar, and died at once; and after death there was found in the middle lobes of the brain an extensive abscess, which had made its way to the surface[¶]. Such cases might, in certain circumstances, be mistaken for the effects of large doses of the hydrocyanic acid; but the morbid appearances are of course quite characteristic. *M. Louis* has related an instance like the last two, but where the disease was altogether latent. His patient after a long illness died of diseased heart, the ventricles of which communicated together. He never had a symptom of disorder of the head; yet on dissection an extensive recent *ramollissement* was found in the right *corpus striatum* and another in the right *thalamus* *.

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[*] On Diseases of the Brain and Spine, Cases 16 and 17.

[†] Recherches sur le Ramollissement de Cerveau, 1819, 1823.

[‡] Recherches Anat. Pathol. sur l'Encephale. 1820.

[§] See also *Dr Abercrombie* on Diseases of the Brain and Spinal Chord, p. 71.

[‖] Opera varia, Venetiis, 1739.—De Mortibus Subitaneis, p. 12.

[¶] London Medical Repository, N. S. ii. 318.

None of the treatises I have seen on the subject make mention of a form of cerebral inflammation intermediate between suddenly fatal cases and those which last several days,—a form in which the patient's illness endures for a few hours only, and which both in the special symptoms and in their course imitates exactly the effects of some narcotics. Two such cases have come under my notice, both of which were judicial, poisoning having been suspected. One of them proved fatal in an hour and a half, the individual having previously been in excellent health; and the only appearance of disease was softening of a considerable part of the surface of the brain where it lies over the left orbit. The other was more remarkable in its circumstances. In November 1822, a man, who had previously enjoyed excellent health, was found one morning in a low lodging-house in the Lawnmarket comatose, and convulsed; and he died seven hours afterwards. The neighbours spread a report, that the woman of the house had poisoned him, with the view of selling the body; and by an odd coincidence the police, when they went to apprehend the woman, found an anatomist hid in a closet. The body was judicially examined by Mr Newbigging and myself; and we found an ulcer on the forepart of the left hemisphere of the brain, and a small patch of softening on each middle lobe.

It is only in cases like the last two that the disease is likely to be mistaken for the effects of poison; and the morbid appearances will at once distinguish them. But it is requisite to remember that softening of the brain when not far advanced is apt to escape notice, as it is not necessarily attended with a change in the colour of the diseased part. In the first of the two cases I have related, the cause of death was very nearly assumed to have been Simple Apoplexy, when at length the true disorder was unexpectedly noticed. I presume, indeed, that strictly speaking, both of the cases which came under my notice ought to be considered as simple apoplexy excited by pre-existing *mollissement.*

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* Recherches Anatomico-Pathologiques, 313.

Of the Distinction between Hypertrophy of the Brain and Narcotic Poisoning.

This disease is not here mentioned because its symptor and progress resemble very closely those of poisoning with tl narcotics; for it causes epileptic symptoms, which, besides th they are preceded for some time by other head affections, vei rarely prove fatal in less than three days. But some notice it is necessary, because the disease is only of recent discover and the appearances left by it in the dead body may escape ol servation. Besides, the physician is at present imperfectl acquainted with it, and therefore, when a more extensive co lection of cases shall have been made, it may be found t prove at times fatal so rapidly as to admit of being confounded with narcotic poisoning. It is always a chronic or slo disease, it is true; but, like other diseases of the brain, its earl stages may possibly be so completely latent that the patient ma appear to die of a few hours' illness. This, however, must b left to the determination of future experience. The most rapid case yet published proved fatal twenty-four hours after th first appearance of symptoms.

The appearances which it leaves in the body are increased density and firmness of the whole or of a part of the brain,—flattening of the convolutions on their outer surface, so that their grooves are almost obliterated and the investing membrane uncommonly dry,—unusual emptiness of the blood-vessels of the brain and its membranes,—and a protrusion of the brain upwards on removal of the skull-cap, as if the brain were too large for its containing cavity *.

Some pathologists doubt the existence of hypertrophy of the brain as a distinct disease, and conceive that the appearance of flattening of the convolutions has been produced by serum effused between the dura mater and arachnoid membrane. But this explanation will not account for the cases lately published, where it is expressly stated that little or no fluid was to be found in any part of the brain or in the base of the skull.

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* *Laennec,* Revue Médicale, 1828, iv. *Dance,* Répertoire Général d'Anatomie Pathologique, vi. 197.

Of the Distinction between Diseases of the Spinal Chord and Narcotic Poisoning.

It is not necessary to say much on the acute diseases of the Spinal Chord, which are apt to be confounded with the effects of narcotic poisons. The diseases are extravasation of blood into the spinal canal, inflammation of the membranes, and inflammation [*ramollissement*] of the chord itself. These disorders are commonly marked by obvious and characteristic symptoms and by a much slower course than that of the affections induced by narcotic poisons. But occasionally they approach closely the characters of some of the slow cases of narcotic poisoning, palsy being absent, the leading symptoms consisting of delirium, convulsions and coma, and the fatal event occurring within the third day. *Dr Abercrombie* and *M. Ollivier* have related examples of the kind arising from extravasation of blood *, serous effusion † and softening of the chord ‡. Such cases are exceedingly rare; but the possibility of their occurrence should impose on the medical jurist the necessity of examining the spine with care in all judicial cases of alleged narcotic poisoning, especially when death has not been rapid.

Of the Distinction between Syncopal Asphyxia, and Narcotic Poisons.

The only other natural disease requiring notice under the present head is the *Asphyxia Idiopathica* of the late Mr Chevalier. It may be the cause of embarrassment in questions regarding narcotic poisoning, when the course of the symptoms to their fatal termination is rapid, and was not witnessed by any person; for it causes death with equal rapidity, and its signs in the dead body are very obscure. It has been observed chiefly among women in the latter months of pregnancy, or soon after delivery; but it has also been known to attack the male sex. It generally commences during a state of perfect health, and is seldom preceded by any warning of danger. The person suddenly complains of slight sickness, giddiness, and excessive faintness, immediately seems to sleep or swoon away, and expires gently without a struggle. The only appearance of note found in the dead body is unusual flaccidity and emptiness of the heart *. But even these slight appearances are no constant; for in a case related by *Rochoux* of a woman who while in a state of perfect health, suddenly grew pale, slippe off her chair, and died on the spot, the auricles of the hear contained a great deal of blood †. This singular disorder appears to consist of nothing else than a mortal tendency to fainting; and it may prove fatal either in the first fit of syncope, or after an hour and a half. A case which Mr Chevalier has quoted from Morgagni, and which lasted four hours, seems to me a case of simple apoplexy, and not the disease in question.

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* On the Diseases of the Brain and Spinal Chord, Case 132.

† Ibidem, Case 131. *Ollivier*, Traité de la moelle épinière, Obs. 42.

‡ *Abercrombie*, Case 138.

Death often takes place in the same way from *Organic Diseases of the Heart*. Such cases may be confounded with the most rapid variety of poisoning with hydrocyanic acid; and if the duration of the symptoms preceding death is unknown, they may give rise to a suspicion of poisoning generally. But they are of course at once distinguished by the morbid appearances. A trivial organic derangement may be the occasion of instant death.

The genera comprehended in the class of Narcotics are Opium, Henbane, Lettuce-Opium, Solanum, Hydrocyanic acid, and the Deleterious Gases. Of these genera the last is by no means a pure one, for it includes many gases which act as irritants only; but it is more convenient to consider them all together, than to distribute them into two separate classes. Some other vegetable substances besides the Henbane, Lettuce-Opium, and Solanum, possess nearly the same properties; but as they likewise cause irritation, they are arranged more appropriately in the next class, the Narcotico-Acrids.

Most of the narcotic vegetables owe their poisonous properties to a peculiar principle, probably of an alkaline nature, and slightly different in each. This discovery was made with regard to opium in 1812; and the discovery of the active principle in that drug has been followed more lately by the detection of analogous principles in most of the narcotics, as well as in many narcotico-acrids.

These principles are generally crystalline, soluble in alcohol and the acids, little soluble in water, free from mineral admixture, and entirely destructible by heat. When purified with the greatest care, they still retain decided alkaline properties; but on account of their number and their low power of neutralization, their alkaline nature was long denied; and they have been conventionally styled alkaloids.

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* London Medico-Chirurgical Transactions, i. 157.

† Recherches sur l'Apoplexie, p. 159.

Leaving the question as to their alkaline nature to be determined by the chemist, it is of more consequence, in regard to the objects of this work, to observe, that they are all highly energetic, and that in them are concentrated all the leading properties of the drugs from which they are procured.

In their natural state they exist in combination with various ternary acids, some of which are peculiar; and they are likewise intimately blended or more probably united chemically with other inert principles of the vegetable kingdom, particularly with resinous and extractive matters, to which they adhere with great obstinacy.

The experiments, which have led to the conclusion, that the narcotic poisons act on the brain by entering the blood-vessels, have been repeated with their alkaloids, and have yielded similar results. But the alkaloids are in equal quantities much more energetic than the crude poisons. Their effects indeed are dreadful, and some well authenticated instances of their action appear hardly less marvellous than the most extravagant notions entertained in ancient times of the operation of poisons. One of them, the principle of nux vomica, which, however, does not belong to the present class, is so active that in all probability a man might be killed with a third part of a grain in less than fifteen minutes.

It is very difficult to detect some of the vegetable alkaloids; and it is fortunate, therefore, that they are rare, and not to be procured but by complex processes.

Chemical analysis does not by any means supply so good evidence of poisoning with the narcotics as it does of poisoning with the irritants. The chemical properties of most of the narcotics are not very characteristic, and they are not well developed unless with a larger quantity of the poison than will usually be met with in medico-legal investigations. This remark, however, does not apply universally; and it is probable, that, as organic analysis goes on improving, better and more delicate processes will be discovered.

CHAPTER XXVII.

OF POISONING WITH OPIUM.

To the medical jurist opium is one of the most importan poisons; since there is hardly any other whose effects co more frequently under his cognizance. It is the poison m generally resorted to by the timid to accomplish self-destr tion, for which purpose it is peculiarly well adapted on acco of the gentleness of its operation. It has also been often source of fatal accidents, which naturally arise from its tensive employment in medicine. It has likewise been lo very improperly employed to create amusement. And in rec times it has been made use of to commit murder, and to indu stupor previous to the commission of robbery. *Mr Burnett*, his work on Criminal Law, has mentioned a trial for murd in 1800, in which the prisoners were accused of having co mitted the crime by poisoning with opium; and although a ve dict of *not proven* was returned, there is little doubt that the d ceased, an adult, was poisoned in the way supposed. A fe years ago, a very remarkable trial took place at Paris, whe poisoning was alleged to have been effected by means of t alkaloid principle of opium; and the prisoner, a young phys cian of the name of Castaing, was condemned and executed.

In several parts of Scotland during the last ten years ma persons have been brought into great danger by opium havi been administered as a narcotic to facilitate robbery, and som have actually been killed. In December 1828, a conviction w obtained in the Justiciary Court of Edinburgh for this crim in which instance the persons who had taken the opium rec vered. A fatal case, which was strongly suspected to be of th same nature, was submitted to me by the Sheriff of this coun in 1828; but sufficient evidence could not be procured. I July 1829 a man Stewart and his wife were condemned, a subsequently executed for the same crime, the person to who they gave the opium having been killed by it. And about year afterwards a similar instance occurred at Glasgow, f which a man Byers and his wife were condemned at the Autu Circuit of 1831.

SECTION I.—*Of the Chemical History and Tests of Opium.*

Opium is the inspissated juice of the capsules of the *Papaver somniferum.* It has a reddish-brown colour, and its fresh surface glistens when cut. It is commonly soft and plastic; but, if pure, may be dried so as to become brittle. Its smell is strong and quite peculiar. Its taste is also peculiar, very bitter, and somewhat acrid. In consequence of its strong peculiar taste one would suppose it no easy matter to administer opium secretly. The plan resorted to by thieves and robbers seems to be, to deaden the sense of taste by strong spirits, and then to ply the person with porter or ale drugged with laudanum, or the black drop, which possesses less odour.

The following account of the chemical history of opium will be confined in a great measure to the leading properties of the principles, in which are concentrated its active qualities, or which are likely by their chemical characters to supply proof of its presence.

The common solvents act readily on opium. Water dissolves its active principles even at low temperatures. So does alcohol. So particularly do the mineral and vegetable acids when much diluted. Ether removes from it little else than one of its active principles, narcotine. By the action of these agents are procured various preparations in common use. *Laudanum* is the spirituous infusion, and contains the active ingredients of a twelfth part of its weight of opium. *Scotch Paregoric Elixir,* a solution in ammoniated spirit, is only one-fifth of the strength of laudanum; and *English Paregoric,* a tincture of opium and camphor, is four times weaker still. *Wine of opium* contains the soluble part of a sixteenth of its weight. The *Black drop* and *Battley's sedative liquor* are believed to be solutions of opium in vegetable acids, and to possess, the former four, the latter three times the strength of laudanum. But their strength has been greatly exaggerated; neither of them, according to my own experience, being above half the strength supposed. The juice and infusion of the garden poppy are also powerfully narcotic, so as even to have caused death both when given by the mouth and in the way of injection*. Many other pharmaceutic preparations contain opium.

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* Archives Gén. xiv. 406.

If opium be infused in successive portions of cold water, tl water dissolves all its poisonous principles, and also a peculi acid possessing characteristic chemical properties. These pri ciples, as well as the acid, are thrown down again and separa ed from various inert matters by boiling the watery infusio with magnesia. The principles thrown down with the magn sia are *morphia*, the alkaloid of opium,—*narcotine*, a poison, n an alkaloid,—a peculiar acid named the *meconic*,—and a *res noid substance.*

In order to separate these principles from one another, th magnesian precipitate is washed, dried, and boiled with pro spirit, which takes up chiefly the narcotine and the resin, leav ing the morphia and the meconic acid,—the latter in unio with magnesia.—The narcotine is separated from the resin b evaporating the proof spirit and treating the residue with ether which dissolves the narcotine and leaves most of the resin.—I order to separate the morphia from the meconate of magnesia they are boiled in strong alcohol, which leaves the meconat and dissolves the former, along with a little resinoid or colouring matter. From this extraneous matter it may be freed b repeated crystallization, or by digesting the alcoholic solution with animal charcoal.—Finally, the meconic acid is procured by digesting the impure meconate of magnesia in diluted sulphuric acid, evaporating to a certain extent, collecting what is deposited on cooling, dissolving it in water, throwing down the meconic acid by acetate of lead, and separating the lead by suspending the washed meconate of lead in water, and transmitting a current of sulphuretted-hydrogen through the mixture. The sulphur unites with the lead, and the hydrogen with the oxygen in the oxide of lead, while the meconic acid, becoming free, is redissolved, and may be procured in impure scaly crystals by evaporation.

This is the simplest mode of showing the composition of opium, but each of its principles may be separately procured by various simpler methods. It must farther be observed that of late no fewer than three new crystalline principles have been detected in opium, namely, *Narceine*, *Meconine*, and *Codeïne*. These, however, exist in very small quantity; and the first two form so minute a proportion that they may be disregarded in a toxicological point of view.

Of the various principles now indicated it is necessary to notice here only morphia, narcotine, codeine, and meconic acid. They require mention either as being active poisons, or because a knowledge of their leading characters will be useful in conducting a medico-legal analysis in a case of poisoning with opium.

Of the Tests for Meconic Acid.—This acid may be procured in various ways more easily than in the manner mentioned above. A convenient mode is to precipitate a strong watery infusion of opium with acetate of lead,—to decompose the impure meconate of lead thus thrown down by suspending it in ten or twelve parts of water, and transmitting a stream of sulphuretted-hydrogen,—to crystallize the acid thus disengaged from the lead by evaporating at a temperature not exceeding 180° F.—and to redissolve the crystals and purify them by subjecting them a second time to precipitation with acetate of lead and decomposition by sulphuretted-hydrogen. In this way, by operating on the large scale, I have procured crystals almost colourless.—Another mode by which a small quantity of very pure acid may be quickly prepared is by mixing the first precipitation of meconate of lead with vitrified boracic acid, and heating the mixture gently in a tube or retort. At a temperature somewhat short of that at which charring takes place, white crystals of meconic acid are sublimed. The latter process is a modification of one proposed by *Choulant* of Dresden in 1818*. Meconic acid, as procured by evaporation, is usually in little scales of a pale brown or yellowish tint, being rendered so by adhering resin or extractive matter; but when nearly colourless, as prepared by the former of the two processes just described, it forms long, extremely delicate, tabular crystals, which in mass have a fine silky appearance like spermaceti. 1. When heated in a tube, it is partly decomposed, and partly sublimed; and the sublimate condenses in filamentous, radiated crystals. 2. When dissolved even in a very large quantity of water, the solution acquires an intense cherry-red colour with the permuriate of iron. The sublimed crystals have the same property. Only one other acid is so affected, namely, the sulpho-cyanic, a very rare substance. It has been repeatedly stated of late [*], that the redness produced meconic acid may be distinguished by the effect of an alk which is said to bleach the colour produced by sulpho-cyanic a but to deepen the cherry-red tint occasioned by the meco This is not correct; an alkali added to the red solution of conate of iron precipitates oxide of iron and renders the liq colourless. 3. Its solution gives a pale-green precipitate w the sulphate of copper, and, if the precipitate is not too ab dant, it is dissolved by boiling, but re-appears on cooling.

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* *Buchner's* Repertorium für die Pharmacie, iv. 62.

Of the Tests for Morphia and its Salts.—Morphia, when pu is in small, beautiful, white crystals. Various forms have be ascribed to them; but in the numerous crystallizations I ha made, it has always assumed when pure the form of a sligh flattened hexangular prism. It has a bitter taste, but no sm

A gentle heat melts it, and if the fluid mass is then allow to cool, a crystalline radiated substance is formed. A strong heat reddens and then chars the fused mass, white fumes of peculiar odour are disengaged, and at last the mass kindles a burns brightly.—Morphia is very little soluble in water. It more soluble, yet still sparingly so, in ether. But its prop solvents are alcohol, or the diluted acids, mineral as well vegetable. All its solutions are intensely bitter, and that alcohol has an alkaline reaction.—From its solutions in the acid crystallizable salts may be procured; and morphia may be s parated by the superior affinity of any of the inorganic alkali more particularly by ammonia; but it is redissolved by an e cess of alkali.—Morphia when treated with nitric acid is di solved with effervescence, and becomes instantly orange-re which, if too much acid has been used, changes quickly to ye low. The colour is said to be destroyed by disoxygenatin agents, such as sulphuretted-hydrogen, or protochloride of tin but this I have never been able to observe. The coloration c morphia by nitric acid is a characteristic property, which it po sesses in common with some other alkaloids, such as brucia, a also strychnia when not quite pure. The change of colour is sa by most chemists to depend on adhering resinoid matter, and n to be possessed by perfectly pure morphia; but I have found it take place strongly in crystals which appeared to me colourle so that we may at all events be sure the property will exist all samples to be found in the shops.—When suspended in water in the form of fine powder and then treated with a drop or two of permuriate of iron containing very little excess of acid, it is dissolved and forms a deep-greenish-blue solution, the tint of which is more purely blue, the stronger the solution is, and the purer the morphia. This is a property even more characteristic than the former, since no such effect is produced on any other known alkaloid. Like the effect of nitric acid, it is said not to be essential to morphia, but to depend on adhering resinoid matter; yet I have remarked the blue colour strongly produced with powdered morphia of snowy whiteness. Another property by which morphia may be also distinguished from all other alkaloids is the decomposition of iodic acid. A solution of iodic acid is turned brown either by morphia or its salts, owing to the formation of iodine. No other alkaloid has the same effect; and the test is so delicate that it affects a solution containing a 7000th of morphia [*].

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[*] London Medical Gazette, viii. 47.

Acetate of Morphia. This salt used to be the common medicinal form for administering morphia; but it has been almost entirely superseded in this city by the muriate, since *Dr W. Gregory* pointed out a cheap mode of procuring that salt in a state of purity [†]. The acetate is in confused crystals, usually of a brownish colour from impurities. The stronger acids disengage acetic acid. The alkalis throw down morphia from its solution in water. Nitric acid and permuriate of iron act on it as on morphia itself.

Hydrochlorate of Morphia.—The muriate or hydrochlorate must be carefully attended to by the medical jurist, because since the discovery by Dr Gregory of a cheap process for preparing it, it has come into extensive use in this city and elsewhere instead of opium. As now prepared, it is almost snowy-white and appears pulverulent, but is in reality a congeries of filiform crystals. It decrepitates slightly when heated, and then melts and at the same time chars, exhaling a strong odour somewhat like that of truffles. Nitric acid and permuriate of iron act on it as on morphia. Boiling water will dissolve fully its own weight, and very easily three-fourths of its weight of hydrochlorate of morphia; and on cooling down to 60° F. it retains seven parts per cent. and deposits the rest in tufts of bea tiful filiform crystals. The solution adopted here for medicin use contains one per cent. of the salt. Nitric acid turns tl solution yellow, acting distinctly enough when the water co tains a hundredth, and perceptibly when it contains only two-hundredth of its weight. Permuriate of iron strikes deep blue with a solution containing a hundredth of its weigh very distinctly when the proportion is a two-hundredth, an even perceptibly when it is only a five-hundredth. A solutio much more diluted than even the last has a strong bitter tast When moderately concentrated, morphia is precipitated fro it by the alkalis.

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[*] *Serullas* Journ. de Chim. Méd. vi.

[†] Edin. Med. and Surg Journal, xxxv. 331.

Of the preceding properties of morphia and its salts, tho which constitute the most characteristic tests are the effects permuriate of iron and of nitric acid on all of them, the effe of heat on morphia, and the effect of an alkali on its solution in acids.

Of the Tests for Narcotine.—Narcotine is rather distinguishe by negative than by positive chemical properties. When pure it is in transparent colourless pearly crystals, which, as forme from alcohol, may be considered as either very flat, oblique six-sided prisms, or oblong four-sided tables obliquely bevelle on their sides. But when crystallized from sulphuric ethe the crystals are prisms with a rhombic base. They fuse wit heat, and concrete on cooling into a resinous-like mass. The are soluble in ether, and fixed oil, less so in alcohol, insolubl in water or the alkalis, very soluble in the diluted acids, bu without effecting neutralization; and if perfectly pure they d not undergo the changes produced on morphia by the permuriate of iron and nitric acid. Few specimens of narcotine, however, are so pure as not to render nitric acid yellow. Care mus be taken not to confound narcotine with morphia, as I hav known some chemists, and have reason to believe some manufacturers, do. When crystallized together from alcohol an not quite pure, the narcotine forms tufts of pearly thin tabula crystals, while the morphia is in short, thick, adamantine, prismatic crystals.

Of Codeïne.—This substance is, like morphia, an alkaloid capable of combining with acids. It differs from morphia an narcotine in being moderately soluble in water; and from th solution it may be crystallized in large crystals affecting the octahedral form. It is unnecessary to detail its chemical properties.

Different accounts have been given by different experimentalists of the proportion of these substances contained in opium. I have procured from half a pound of the best Turkey opium 3½ drachms of very pure Morphia, and two drachms of Narcotine. *M. Dublanc* has lately made many analyses, and procured as the mean of six trials eight per cent. of morphia, and three per cent. of narcotine. In the indigenous poppy the quantity varies much. The last experimentalist found in one sample of French opium only two per cent. of morphia, in another 5.7 per cent [*]. *M. Petit* has procured 6.3 per cent. from the extract of the stems, leaves, and capsules taken together, sixteen or even eighteen per cent. from French opium, and eight per cent. from Turkey opium [†]. *M. Caventou* has more recently got from some specimens of French opium so much as twenty-two and even twenty-eight per cent. [‡] *Biltz* of Erfurt got from indigenous German opium 16½ and even 20 per cent. of morphia where the opium had been prepared from the purple poppy, and between 6¼ and 9½ narcotine; while from opium made from the white poppy he got conversely 6.8 per cent. of morphia and so much as 33 per cent. of narcotine [§]. The average produce of muriate of morphia procured by *Dr Gregory* is ten per cent. from good Turkey opium. The proportion of meconic acid has not yet been determined. It is important in relation to medico-legal analysis to observe that Battley's solution contains very little meconic acid, not indeed above one-twelfth of what is contained in an equal quantity of opium. East India opium I have found to contain less morphia, and more narcotine than Turkey opium; Codeïne forms about a 30th of the muriate of morphia of the shops as prepared from good Turkey opium. But in some samples of the muriate prepared from first-rate Turkey opium I have found the proportion of codeïne to be greatly less: while in a sample of Malwa opium of private manufacture I obtained from the muriate of morphia no less than a twelfth of that principle.

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[*] Journ. de Chim. Méd. iii.

[†] Journ. de Pharm. xiii. 183.

[‡] Archives Gén. de Méd. xii. 621.

[§] Annalen der Pharmacie, iv. 235. I have no doubt that where chemists talk of 16, 18, and 20 per cent. of morphia being obtained from opium, they speak of an impure morphia. No one who has not carefully attended to the subject can be aware how much a slightly coloured morphia loses before being thoroughly purified.

Of the Process for detecting Opium in mixed fluids and solids.

Having stated these particulars of the chemical history of opium and its chief component ingredients, I shall now describe what has appeared to me the most delicate and satisfactory method of detecting it in a mixed state.

1. If there is any solid matter it is to be cut into small fragments, water is to be added if necessary, then a little acetic acid sufficient to render the mixture acidulous, and when the whole mass has been well stirred and has stood a few minutes, it is to be filtered, and evaporated at a temperature somewhat below ebullition to the consistence of a moderately thick syrup. To this extract strong alcohol is to be gradually added, care being taken to break down any coagulum which may be formed; and after ebullition and cooling, the alcoholic solution is to be filtered. The solution must then be evaporated to the consistence of a thin syrup, and the residue dissolved in distilled water and filtered anew.

2. Add now the solution of acetate of lead as long as it causes precipitation, filter and wash. The filtered fluid contains the morphia, and the precipitate on the filter contains meconic acid united with the oxide of lead.

3. The fluid part is to be treated with sulphuretted-hydrogen to throw down any lead which may remain in solution. I is then to be filtered while *cold*, and evaporated sufficiently in a vapour-bath. The solution in this state will sometimes be sufficiently pure for the application of the tests for morphia but in many cases it is necessary, and in all advisable, to purify it still farther. For this purpose the fluid is to be precipitated with ammonia; and the precipitate having been collected, washed, and drained on a filter, the precipitate and portion of the filter to which it adheres are to be boiled in a little pure alcohol. The alcoholic solution, filtered, if necessary, will give by evaporation a crystalline residue, which becomes orange-red with nitric acid, and blue with permuriate of iron. The latter

property I have sometimes been unable to develope when the former was presented characteristically.

4. It is useful, however, to separate the meconic acid also; because, as its properties are more delicate, I have repeatedly been able to detect it satisfactorily, when I did not feel satisfied with the result of the search for morphia. *Dr Ure* made the same remark in his evidence on the trial of Stewart and his wife. He detected the meconic acid, but could not separate the morphia. Suspend, therefore, in a little water the precipitate caused by the acetate of lead (par. 2); transmit sulphuretted-hydrogen till the whole precipitate is blackened; filter immediately without boiling; then boil, and if necessary filter a second time. A great part of the impurities thrown down by the acetate of lead will be separated with the sulphuret of lead; and the meconic acid is dissolved. But it requires in general farther purification, which is best attained by again throwing it down with acetate of lead, and repeating the steps of the present paragraph. The fluid is now to be concentrated by evaporation, and subjected to the tests for meconic acid, more particularly to the action of perchloride of iron, when the quantity is small. If there is evidently a considerable quantity of acid, a portion should be evaporated till it yields crystalline scales, which have always a yellowish tint; and these are to be heated in a tube to procure the arborescent crystalline sublimate formerly described. About a sixth of a grain of meconic acid, however, is required to try the latter test conveniently.

I wish I could add my testimony to the opinion, expressed on a remarkable occasion by *Professor Chaussier*, in favour of the delicacy of the tests for morphia and its compounds, that they might be detected "jusqu'à une molécule *." To a certain extent this statement may be correct. Morphia, separated from the complex mixture of principles with which it is combined in opium, may be detected in extremely small quantities. Accordingly, *M. Lassaigne* has not long ago supplied, for the discovery of acetate of morphia in mixed fluids, an excellent process, from which the chief part of the three first paragraphs of the preceding method for opium are borrowed; and from the facts stated by him in his paper †, as well as from the experimental testimony of *Professor Orfila* *, it appears that Lassaigne's proce will furnish strong indications, if not absolute proof of the pr sence of that salt, in the proportion of two grains to eight ou ces of the most complex mixtures. Hence the search for ac tate of morphia in a suspected case is by no means hopele But the detection of acetate of morphia is an object of sma moment compared with the detection of morphia in its natu state of combination in opium. Now my own observatio lead me to entertain serious doubts whether the method c Lassaigne could be successfully applied to the analysis of complex mixtures, which instead of the proportion of acetate c morphia mentioned above, namely, two grains in eight ounce contained the corresponding proportion of opium, that is a scrupl of solid of opium, or four drachms of laudanum. By the proces I have recommended it is easy to procure, from an infusion o ten grains of opium in four ounces of water, satisfactory proo of the presence of morphia by the action of ammonia, perchloride of iron and nitric acid, and equally distinct proof of th presence of meconic acid by the permuriate of iron, as well a by the sulphate of copper. But on proceeding to apply the process to organic mixtures, I have found that when the soluble part of ten grains of opium was mixed with four ounces of porter or milk, I could develope no other property of morphia except its bitterness, and could obtain but faint indications of meconic acid by the action of permuriate of iron.

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* Procès de Castaing, p. 113.

† Ann. de Chim. et de Phys. xxv. 102.

It is of great consequence, however, to remark, that in the generality of cases of poisoning with opium, the medical jurist will seldom have the good fortune to operate even upon so large a proportion of the poison; because, for reasons formerly mentioned (p. 15 and 56,) the greater part of it disappears from the stomach before death. This will not happen always, as may be seen from various cases mentioned in the Section on the morbid appearances caused by opium. But, according to my own observations, the poison will often disappear in a short time, so far as to render an analysis abortive. Thus in the case of a young woman who died five hours after taking not less than two ounces of laudanum, I could apply to the fluid, procured from the contents of the stomach by paragraphs 1, 2, and 3 of my process, only the test of its taste, which had the bitterness of morphia. In the case of another young woman, whose stomach was emptied by the stomach-pump four hours after she took two ounces of laudanum, I could obtain from the evacuated fluid, when properly prepared, only the indications of the presence of morphia supplied by its bitterness and the imperfect action of nitric acid,—and the indication of the presence of meconic acid supplied by the imperfect action of perchloride of iron. In a third case, where the stomach was evacuated two hours after seven drachms of laudanum had been swallowed, even the first portions of fluid withdrawn had not any opiate odour, and did not yield any indication of the presence even of meconic acid. Now, on the one hand, the quantity taken in these instances is rarely exceeded in cases of poisoning with laudanum; and, on the other hand, the interval during which it remained in the stomach subject to vital operations is considerably less than the average in medico-legal, and above all in fatal cases. It may be laid down, therefore, as a general rule, that in poisoning with opium the medical jurist, by the best methods of analysis yet known, will often fail in procuring satisfactory evidence, and sometimes fail to obtain any evidence at all, of the existence of the poison in the contents of the stomach.—In a case published by *Dr Bright* from the experience of *Mr Walne* of London, it is stated that the matter removed from the stomach only half an hour after an ounce and a half of laudanum had been taken, while the stomach was empty, did not smell of opium *. This case is quoted to put the reader on his guard; but at the same time it does appear extremely improbable that the whole opium had disappeared from the stomach in so short a time, and much more likely that it might have been found by analysis in the matter first withdrawn.

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* Toxicol. Gén. ii. 60.

I have taken some pains to establish the proposition laid down above, because in a matter of such importance it is always essential that the medical inspector know the real extent of his resources; and it has appeared to me that, greatly as the hand of the chemist has been strengthened by the late discoveries in vegetable analysis, his power has been overrated both by his scientific brethren, and by the medical profession generally. I am happy to find, since the first publication of these remarks, that they coincide with the experience and opinion of so ei nent an authority as *Professor Buchner*, who has observed tha chemical analysis must often fail to detect opium where the could be no doubt of its having been administered in large qua tity [*].

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* Reports of Medical Cases, ii. 203.

It is of moment to add, that in two of the instances mei tioned above the odour of laudanum was perceived in the sul ject of analysis,—faintly, however, and only for a few hou after it was removed from the stomach. Although the peculia odour of opium is a delicate criterion of its presence, it doe not follow that it should be preferred to an elaborate chemica analysis. For it is a test of extreme uncertainty. There is i the contents of the stomach such a complication of odours, tha with a rather delicate sense of smell, I have sometimes been unable to satisfy myself of the presence of the opiate odour where others were sure it existed. At the same time the medical jurist should not neglect it as a subsidiary test. It is always strongest and most characteristic, first when the stomach is just opened, or the contents just withdrawn, and again when the fluid, in the course of preparation, as directed in paragraph 1, (p. 639,) is just reaching the point of ebullition. The latter odour is somewhat different from the former, yet quite peculiar, and such as every chemist must have remarked on boiling an infusion of opium.

So much for the delicacy of the process. As to its precision, it is necessary to observe, that from what I have myself witnessed, as well as from the experience of Dr Ure, it will often happen in actual practice, that the only indication of opium to be procured by the process consists in the deep red colour struck by permuriate of iron with the meconic acid. Now, will this alone constitute sufficient proof of the presence of opium? On the whole, I am inclined to reply in the affirmative. Sulpho-cyanic acid, it is true, has the same effect, and this acid has been proved by *Professors Gmelin* and *Tiedemann* to exist in the human saliva [†],—a fact which was called in question by *Dr Ure* in his evidence on the trial of the Stuarts, but which at the time I had verified, and which Dr Ure has since been compelled by experiments of his own to admit [*]. But it is seldom possible to procure a distinct blood-red coloration from the saliva, except by evaporating a large quantity to dryness, and redissolving the residue in a small quantity of water; and I question whether it can be separated at all after the saliva is mixed with the complex contents of the stomach.

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[*] Repertorium für die Pharmacie, xxxi. 174.

[†] Die Verdauung nach Versuchen, &c.

Paragraph 4 of the process I have recommended is somewhat similar to a method lately proposed by *Mr Hare* of Philadelphia, for the detection of opium by the separation of the meconic acid; but it was taught in my class before his process was published; and I owe it to the instructions of M. Robiquet of Paris in 1820. Mr Hare's mode of procedure, however, deserves mention, as it is ingenious and easily managed. He proposes to add the solution of acetate of lead to the suspected fluid in a conical glass vessel, and to allow the precipitate to subside, which may take six or twelve hours. The meconate of lead being collected at the bottom in a small mass, some drops of sulphuric acid are to be poured through a tube on it. In the same manner, the solution of permuriate of iron is to be added; when the cherry-red colour of the meconate of iron will be struck. This test acts on ten drops of laudanum, mixed with eighty ounces of water [*].— A better way of applying it, is to remove the superincumbent fluid after the precipitate has subsided, to add the sulphuric acid to the remainder placed in a tube, to assist its action with gentle heat, and to drop in the permuriate of iron, after allowing the mixture to remain at rest for a few minutes till the sulphate of lead subsides. According to the plan suggested by Mr Hare, the effervescence produced by the sulphuric acid diffuses the precipitate through the superincumbent fluid, should any carbonate exist there previous to the addition of acetate of lead.—Mr Hare's method obviously cannot apply to deeply-coloured fluids, or to complex organic mixtures, though not deeply coloured; for the quantity of organic matter thrown down with the meconate of lead will disguise the colour of the meconate of iron sufficiently to prevent the analyst from drawing a confident conclusion as to the presence of meconic acid. The more complicated process which

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[*] Journal of Science, N. S. vi. 56.

[†] Philadelphia Journal of the Medical and Physical Sciences, v. 77.

I have recommended will therefore be in general necessary.—*M. Dublanc* has published a process for the acetate of morphia[*], differing considerably from that of Lassaigne, on which mine is founded. But Professor Orfila, on comparing the two methods, has given the decided preference to that of Lassaigne, and points out material inconveniences to which that of Dublanc is liable[†]. Orfila has not given any process for the detection of opium.

SECTION II.—*Of the Action of Opium, and the Symptoms it excites in Man.*

The symptoms and mode of action of Opium have been long made the subject of dispute, both among physicians and toxicologists; and in some particulars our knowledge is still vague and insufficient.

Under the head of general poisoning, some experiments were related, from which it might be inferred that opium has the power of stupefying or suspending the irritability of the parts to which it is immediately applied. The most unequivocal of these facts, which occurred to *Dr Wilson Philip*, was instant paralysis of the intestines of a dog, when an infusion of opium was applied to their mucous coat[‡]; another hardly less decisive was palsy of the hind-legs of a frog, observed by *Dr Monro Secundus*, when opium was injected between the skin and the muscles[§]; and a third, which has been remarked by several experimentalists, is immediate cessation of the contractions of the frog's heart, when opium is applied to its inner surface[||].

This poison has also powerful constitutional or remote effects, which are chiefly produced on the brain. Much discussion has arisen on the question, whether these constitutional effects are owing to the conveyance of the local torpor along the nerves to the brain, or to the poison being absorbed, and so acting on the brain through the blood. The question is not yet settled. It appears pretty certain, however, that the poison cannot act constitutionally without entering the blood-vessels; although it is not so clear, that after it has entered them, it acts by being carried with the blood to the brain. The newest doctrine supposes that it enters the blood-vessels, and produces on their inner coat an impression which is conveyed along the nerves.

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[*] Journ. de Pharmacie, x. 425.

[†] Toxicol. Gén. ii. 60.

[‡] Experiments on Opium. Appendix to Treatise on Febrile Diseases, iv. 697.

[§] Edin. Lit. and Phys. Essays, iii. 309.

[||] Monro, *Ibidem*, 331, and Philip, *ut supra*, p. 680.

According to the experiments of *Professor Orfila*, it is most energetic when most directly introduced into the blood: It is more energetic when applied to the surface of a wound than when introduced into the stomach, and most energetic of all when injected into a vein *. The inference generally drawn from these and other analogous experiments † is, that the blood transmits the poison in substance to the brain. They certainly, however, do not prove more than that the poison must enter the blood before it acts.

The old doctrine, that the blood-vessels have no concern with its action, and that it acts only by the conveyance along the nerves of the peculiar local torpor arising from its direct application to their sentient extremities, has been long abandoned by most physiologists as untenable. But some have adopted a late modification of this doctrine, by supposing that opium may act both by being carried with the blood to the brain, and by the transmission of the local torpor along the nerves. They believe, in fact, that opium possesses a double mode of action, —through sympathy as well as through absorption. It would be fruitless to inquire into the grounds that exist for adopting or rejecting this doctrine, because sufficient facts are still wanting to decide the controversy. So far as they go, however, they appear adverse to the supposition of a conveyance of impressions along the nerves, without the previous entrance of the poison within the blood-vessels.

All the difficulties, in the way of the theory of the sympathetic action of opium, are removed by the doctrine of *Messrs Morgan and Addison*. According to their views, the experiments, which appear at first sight to prove that this substance operates by being carried with the blood to the part on which it acts, are easily explained by considering that the opium makes a peculiar impression on the inside of the vessels, which im-

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* Toxicol. Gén. ii. 77.

† *Monro*, Edin. Phys. and Lit. Essays, ii. 335, 324.—*Charret*, Revue Médicale, 1827, i. 515.

pression subsequently passes along the nerves to the brain
For the proofs these gentlemen have advanced in support o their opinion, the reader is referred to the introductory chapter on the physiology of poisoning.

The effects of opium, through whatever channel it may produce them, are exerted chiefly on the brain and nervous system. This appears from the experiments of a crowd of physiologists, as well as from the symptoms observed a thousand time in man. In animals the symptoms are different from those remarked in man. Some experimentalists have indeed witnesse in the higher orders of animals, as in the human subject, pure lethargy and coma. But the latest researches, among the res those of *M. Orfila*, show that much more generally it causes in animals hurried pulse, giddiness, palsy of the hind-legs, convulsions of various degrees of intensity from simple tremors to violent tetanus, and a peculiar slumber, in the midst of which a slight excitement rouses the animal and renews the convulsions. These symptoms are produced in whatever way the poison enters the body, whether by the stomach, or by a wound, or by direct injection into a vein, or by the rectum. In man convulsions are sometimes excited; but much more commonly simple sopor and coma.

According to the most recent inquiries, those of *M. Charret*, which were extended to every class of the lower animals, opium produces three leading effects. It acts on the brain, causing congestion and consequently sopor; on the general nervous centre as an irritant, exciting convulsions; and on the muscles as a direct sedative. It is poisonous to all animals,—man, carnivorous quadrupeds, the *rodentia*, birds, reptiles, amphibious animals, fishes, insects, and the *mollusca*. But of its three leading effects some are not produced in certain classes or orders of animals. In the *mammalia*, with the exception of man, there is no cerebral congestion induced, and death takes place amidst convulsions. In birds there is some cerebral congestion towards the close; but still the two other phenomena are the most prominent [†].

It has been rendered probable by what is stated above, that opium enters the blood. The question, therefore, naturally

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[*] On the operation of Poisonous Agents on the Living Body, *passim*.

[†] Revue Médicale, 1827, i. 514.

arises, whether its presence there can be proved by chemical analysis? But considering the imperfection of the processes for detecting it when mixed with organic substances, no disappointment ought to be felt if this proof should fail in regard to so complex a fluid as the blood. The only person who has represented himself successful in the search is *M. Barruel* of Paris. He examined the urine and blood of a man under the influence of a poisonous dose of laudanum, amounting to an ounce and a half; and procured indications of morphia in both. When three ounces of the urine were boiled with magnesia, and the insoluble matter was collected, washed, dried and boiled in alcohol, the residue of the alcoholic solution formed a white stain, which became deep orange-red on the addition of nitric acid. The blood was subjected to a more complex operation. One pound ten ounces of it were bruised in a mortar, diluted with two pounds of water, strongly acidulated with sulphuric acid, boiled, filtered, and washed. The filtered fluid was saturated with chalk, and the excess of carbonic acid driven off by heat. The fluid was then filtered again, and after being washed with water, was acted on by diluted acetic acid. The acetic solution left on evaporation a residue which was repeatedly acted on by alcohol; and the residue of the alcoholic solutions was treated with pure alcohol and carbonate of lime. The new solution when filtered and evaporated left several small white stains, which became orange-red with nitric acid [*]. These results have been since contradicted by *M. Dublanc.* He in vain sought for morphia in the blood and urine of people who were taking the acetate medicinally, or of animals that were killed by it [†]. Barruel's results are also at variance with some pointed experiments of *M. Lassaigne*, who could not detect any acetate of morphia even in blood drawn from a dog twelve hours after thirty-six grains were injected into the crural vein [‡].

In investigating the effects of opium and its principles on Man, the natural order of procedure is to consider in the first place those of opium itself in its various forms.

The effect of a small dose seems to be generally in the first instance stimulating: The action of the heart and arteries is i creased, and a slight sense of fulness is caused in the hea This stimulus differs much in different individuals. In mo persons it is quite insignificant. In its highest degree it is we exemplified by *Dr Leigh* in his Experimental Inquiry, as the occurred to a friend of his who repeatedly made the exper ment. If in the evening when he felt sleepy, he took thirt drops of laudanum, he was enlivened so that he could resum his studies; and if, when the usual drowsiness approachec which it did in two hours, he took a hundred drops more, h soon became so much exhilarated, that he was compelled t laugh and sing and dance. The pulse meanwhile was full an strong, and the temporal arteries throbbed forcibly. In n long time the customary torpor ensued. The stimulant effec of opium given during a state of exhaustion is also well illustrated by *Dr Burnes* in his account of Cutch. "On one occasion," says he, "I had made a very fatiguing night march witl a Cutchee horseman. In the morning, after having travellec above thirty miles, I was obliged to assent to his proposal o halting for a few minutes, which he employed in sharing a quantity of about two drachms of opium between himself and his jaded horse. The effect of the dose was soon evident on both, for the horse finished a journey of forty miles with great apparent facility, and the rider absolutely became more active and intelligent." *

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[*] Archives Gén. vii. 558.

[†] Ibid. xi. 150.

[‡] Ann. de Chim. et de Phys. xxv. 102.

By repeating small doses frequently, the stimulus may be kept up for a considerable time in some people. In this way are produced the remarkable effects said to be experienced by opium-eaters. These effects are described as always in the first instance stimulant, the imagination being rendered brilliant, the passions exalted, and the muscular force increased; and this state endures for a considerable time before the usual stage of collapse supervenes. A very poetical, but I believe also a faithful, picture of the phenomena now alluded to is given in the Confessions of an English Opium-eater,—a work published not long ago by a gentleman who writes from personal experience. It is singular that our profession should have observed these phenomena so little, as to be accused by the author of having wholly misrepresented the action of the most common drug in medical practice. In reply to this charge the physician may simply observe, that he seldom administers opium in the way practised by the opium-eater; that when given in the usual therapeutic mode it rarely causes material excitement; that some professional people prefer giving it in frequent small doses, with the view of procuring its sedative effect with greater certainty, and undoubtedly do succeed often in attaining their object; that in both of these medicinal ways of administering it, excitement is occasionally produced to a very great degree and of a very disagreeable kind; that the latter phenomena have been clearly traced to idiosyncrasy; and therefore that the effects on opium-eaters are probably owing either to the same cause, or to the modifying power of habit. This much at all events is certain,—that opium seldom produces material excitement in a single small dose, and does not always cause continuous excitement when taken after the manner of the opium-eater. The effect of a full medicinal dose of two or three grains of solid opium, or forty or sixty grains of the tincture, is to produce in general a transient excitement and fulness of the pulse, but in a short time afterwards torpor and sleep commonly succeeded in six, eight, or ten hours by headach, nausea, and dry tongue.

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* Narrative of a Visit to the Court of Sinde, p. 231.

The symptoms of poisoning with opium when it is administered at once in a dangerous dose, begin with giddiness and stupor, generally without any previous stimulus. The stupor rapidly increasing, the person soon becomes motionless and insensible to external impressions; he breathes very slowly, generally lies quite still, with the eyes shut and the pupils contracted; and the whole expression of the countenance is that of deep and perfect repose. As the poisoning advances, the features become ghastly, the pulse feeble and imperceptible, the muscles excessively relaxed, and, unless assistance is speedily procured, death ensues. If the person recovers, the sopor is succeeded by prolonged sleep, which commonly ends in twenty-four or thirty-six hours, and is followed by nausea, vomiting, giddiness, and loathing of food.

The period which elapses between the taking of the poison and the commencement of the symptoms is various. A large quantity, taken in the form of tincture and on an empty stomach, may begin to act in a few minutes; but for obvious reasons it is not easy to learn the precise fact as to this particular. *Dr Meyer*, late medical inspector at Berlin, has related a case of poison with six ounces of the saffron tincture of opium, where the ɪ son was found in a hopeless state of coma in half an hour[*], *M. Ollivier* has described another instance of a man who found completely soporose at the same distance of time a taking an ounce and a-half of laudanum [†]. In these cases, th the symptoms must have begun in ten or fifteen minutes at thest. In a case noticed by *M. Desruelles* the sopor was fai formed in fifteen minutes after two drachms of solid opium w taken [‡]. For the most part, however, if opium is taken in solid form, it does not begin to act for half an hour or e almost a whole hour,—that period being required to allow poisonous principles to be separated and absorbed by the bib lous vessels. It is singular that an interval of an hour was marked in a case where the largest quantity was taken whi has yet been recorded. The patient swallowed eight oun of crude opium; but in an hour her physician found her al to tell connectedly all she had done; and she recovered [§]. some rare cases the sopor is put off for a longer period: Th in a case mentioned in Corvisart's Journal there seems to ha been no material stupor till considerably more than an hour ter the person took two ounces and a-half of the tincture wi a drachm of the extract [||]. I am not acquainted with any instan of a longer interval where the case was one of pure poisonin with opium. But there is some reason for thinking that tl interval may be much longer, if at the time of taking the opiu the person be excited by intoxication from previously drin ing spirits. *Mr Shearman* has related a striking case of a hab tual drunkard, who while intoxicated to excitement with be and spirits took two ounces of laudanum, and had no materi stupor for five hours, during which period vomiting could n be induced. Five hours afterwards, he was found insensible, an he eventually died under symptoms of poisoning with opium [¶]

The most remarkable symptom in the generality of cases c poisoning with opium is the peculiar sopor. This state differs from coma in the patient continuing long capable of being roused. It may be difficult to rouse him; but unless death is very near, this may be almost always accomplished by brisk agitation, tickling the nostrils, loud speaking, or the injection of water into the ear. The state of restored consciousness is always imperfect, and is speedily followed again by lethargy when the exciting power is withheld. It has been already remarked, that the possibility of rousing the patient from the lethargy caused by opium is in general a good criterion for distinguishing the effects of this poison from apoplexy and epilepsy.

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[*] Rust's Magazin, iii. 24.

[†] Archives Gén. vii. 550.

[‡] Journal Universel, xix. 340.

[§] American Medical Recorder, xiii. 418, from Gemeinsame Deutsche Zei schrift für Geburtshulfe, 1826, i. 1.

[||] Corvisart's Journal de Médecine, xvi. 22.

[¶] Lond. Med. and Phys. Journal, xlix. 119.

It was observed, in describing the mode of action of opium, that convulsions, although very regularly produced by it in animals, are rarely caused in man. It is not easy to account for this difference. *Orfila* has endeavoured to explain it, by supposing that convulsions are produced only by very large doses; but there are many cases incompatible with that supposition.

While convulsions are certainly not common in the human subject, yet when they do occur they are sometimes very violent. *Tralles* mentions that he had himself several times seen convulsions excited in children by moderate doses *. The Journal Universel contains the case of a soldier who took two drachms of solid opium, and died in six hours and a-half, after being affected with locked-jaw and dreadful spasms †. A very pointed case of the same kind is related in the Medical and Physical Journal. It is the case of a young man, who, after swallowing an ounce of laudanum, told what he had done, so that he was seen within three hours by his surgeon. At that time he was insensible, the mouth was distorted, the jaws fixed, and the hands clenched. Afterwards the insensibility was lessened by proper remedies; and then he was seized with spasms of the back, neck, and extremities, so violent as to resemble opisthotonos ‡. Another good case of the kind is related by *Mr M'Kechnie*, where the voluntary muscles were violently convulsed in frequent paroxysms, and were affected in the intervals with subsultus for three hours before the sopor came on §. Two instances of con-

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* De Usu Opii, iv. 149.

† Journal Universel, xix. 340.

‡ London Med. and Phys. Journal, xxxi. 468.

§ Edin. Med. and Surg. Journal, vii. 305.

vulsions alternating with sopor are shortly related by *Dr Brigh*
The convulsions sometimes assume the form of permanent spas
which may affect the whole muscles of the body, as in a ca
related in Corvisart's Journal [†].—Another rare symptom of p
soning with opium is delirium. It appears to occur occasic
ally along with convulsions, as happened in Mr M'Kechni
case, and in one related by *M. Ollivier* [‡].

The state of the pulse varies considerably. In a very int
resting case described by *Dr Marcet* it is mentioned that t
pulse was 90, feeble and irregular; and such appears to be
most common condition when the dose has been so large
seriously to endanger life [§]. Very frequently, however, it
much slower; and then it is rather full than feeble, just as
apoplexy. In the cases where convulsions occur, it is for tl
most part hurried, and does not become slow till the coma b
comes pure. In Mr M'Kechnie's case the pulse was at fi
126; but when the convulsions ceased, and pure sopor supe
vened, it fell to 55. It always becomes towards the close ve
feeble, and at length imperceptible.

The respiration is almost always slow. In Dr Marcet's cas
as in some others, it was stertorous; but this is not commo
On the contrary, it is more frequently very gentle, as it h
been in all the cases I have witnessed; and sometimes it ca
hardly be perceived even in persons who eventually recove
An instance is recorded by *Dr Kinnis*, where the breathin
could not be perceived without great attention; yet the patien
recovered [‖].

The pupils are always at least sluggish in their contraction
often quite insensible;—sometimes they are said to have bee
dilated [¶]; but much more commonly they are contracted, an
occasionally to an extreme degree. In the case last notice
they were no bigger than a pin's head. The pupils have bee
so invariably found contracted in all recent cases of poisonin
with opium that some doubt arises whether they are ever other
wise, and whether the earlier accounts, which represent the pu

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[*] Reports of Medical Cases, ii. 205, 206.

[†] Journal de Médecine, xvi. 21.

[‡] Arch. Gén. vii. 552.

[§] London Med. Chir. Trans. i. 77.

[‖] Edin. Med. and Surg. Journal, xiv. 603.

[¶] Journ. Universel, xix. 340.

pils to have been dilated, may not be incorrect, and the result of loose or hasty observation.

The expression of the countenance is for the most part remarkably placid, like that of a person in a sound natural sleep. Occasionally there is an expression of anxiety mingled with the stupor. The face is commonly pale. Sometimes, however, it is flushed [*]; and in rare cases the expression is furious [†].

In moderately large doses opium generally suspends the excretion of urine and fæces; but it promotes perspiration. In dangerous cases the lethargy is sometimes accompanied with copious sweating. In a fatal case, which I examined judicially, the sheets were completely soaked to a considerable distance around the body.

A remarkable circumstance which has been noticed by a late author is the sudden death of leeches applied to the body. The patient was a child who had been poisoned by too strong an injection of poppy-heads [‡].

For the most part the person who recovers from the stupor caused by opium is soon restored to health, weakness of the stomach continuing for a few days. In a case, however, related in Corvisart's Journal, there were convulsions and somnolency on the third day; palsy of one arm continued for four days; and for nearly two months afterwards the patient complained of occasional attacks of weakness and numbness, sometimes of one extremity, sometimes of another [§]. Here the brain must have sustained some more permanent injury than usual.

Notwithstanding the purely narcotic or nervous symptoms, which opium produces in a vast proportion of instances, there is no doubt that it produces in a few rare cases those of irritation also. Thus, although it generally constipates the bowels, it has been known to induce diarrhœa or colic in particular constitutions. In the first volume of the Medical Communications, it is observed by Michaëlis that both diarrhœa and diuresis may be produced by it. The soldier, whose case was quoted as having been accompanied with convulsions, had acute pain in the stomach for some time after swallowing the poison; and in the case just quoted from Corvisart's Journal, the accession o the somnolency was attended with excruciating colic pain c two days' duration.

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[*] Edin. Med. and Surg. Journ. vii.

[†] Journ. Universel, xix. 340.

[‡] *Mélier* in Archives Gén. de Méd. xiv. 406.

[§] Corvisart's Journ. de Méd. xvi. 21.

Another and a more singular anomaly is the spontaneous occurrence of vomiting. Sometimes a little vomiting immediately succeeds the taking of the poison. This may not interrupt however, the progress of the symptoms [*]; but more commonly it is the means of saving the person's life, as in a strikin case described by *Petit* of an English officer [†], who, in consequence of vomiting immediately after taking 2 oz. of laudanum had only moderate somnolency. At other times vomiting occurs at a much later period. *Pyl*, in his Essays and Observations, gives a case in which, some hours after thirty grains were swallowed, vomiting took place spontaneously, and recurred frequently afterwards; and in the same paper is an account of another case by the individual himself, who attempted to commit suicide by taking a large dose of laudanum, but was disappointed in consequence of the poison being spontaneously vomited after the sopor had fairly set in [‡]. Vomiting is a common enough symptom after the administration of emetics, or subsequent to the departure of the somnolency [§].

Another anomaly has been mentioned by a writer of high authority, the author just quoted, namely, complete remission of all the symptoms, even for days together, and subsequent renewal of them. The possibility of such a remission must be received with great hesitation. It is well known that most of the symptoms may be dispelled by vigorous treatment, and the patient nevertheless relapse immediately if left to himself, and even die. This is acknowledged on all hands. But the remission mentioned by *Pyl* is much more complete and long. The case which led him to admit it is shortly as follows. A man who had taken a large quantity of opium, and became very dangerously ill, was made to vomit in twelve hours, and regained his senses completely. The bowels continued obstinately costive; but he had for some days no other symptom referrible to the poison; when at length the whole body became gradually palsied and stiff, and he died on the tenth day. No importance can be attached to a solitary case, differing so widely from every other. The only way in which opium could cause death in such a manner, must be by calling forth some disposition to natural disease. Pyl's case was probably one of *Ramollissement*, or Inflammation of the substance of the brain [*].

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[*] *Ollivier's* case in Arch. Gén. vii. 550.

[†] *Corv.* Journ. de Méd. xxxiv. 274.

[‡] Aufsätze und Beobachtungen, i. 94, 100.

[§] These effects must not be confounded with those which poppy-juice has been known to cause when spoiled. A whole family of Jews were attacked with violent vomiting and purging, in consequence of partaking of a decoction of poppy-heads, which had been kept four days in a hot stove, and had consequently undergone decomposition. The usual narcotism was not produced at all. (*Rust's* Magazin, xxii. 484.)

The ordinary duration of a fatal case of poisoning with opium is from seven to twelve hours. Most people recover who outlive twelve hours. At the same time fatal cases of longer duration are on record: *Réaumur* mentions one which proved fatal in fifteen hours [†], *Orfila* another fatal in seventeen hours [‡]. *Leroux* another fatal in the same time [§], *Alibert* another fatal in nearly twenty-four hours [‖]. I should add, that an instance has even been related which appeared to prove fatal not till towards the close of the third day [¶]; but the whole course of the symptoms was in that case so unusual, that I suspect some other cause must have co-operated in occasioning death. Sometimes, too, death takes place in a shorter time than seven hours; six hours is not an uncommon duration; I met with a judicial case not long ago, which could not have lasted above five hours; an Infirmary patient of my colleague, Dr Home, died in four hours; in the 31st volume of the Medical and Physical Journal, there is one which proved fatal in three hours [**]. This is the shortest I have read of.

The dose of opium requisite to cause death has not been determined. Indeed it must vary so much with circumstances, that it is almost vain to attempt to fix it. *Pyl* relates a case, which appears to have been quickly fatal, and where the quantity taken was 60 grains [*]; *Lassus* an instance of death from 36 grains [†]; and *Wildberg* has related in his Practical Manual a fatal case caused by little more than half an ounce of the tincture [‡], which, as prepared according to the Berlin Pharmacopœia, contains the soluble matter of forty grains. *Dr Paris*, without quoting any particular fact, says four grains may prove fatal [§]. I should have had some difficulty in admitting this statement, as I have repeatedly known persons unaccustomed to opium take three or four grains without any other effect than a sound sleep. But I have been favoured with the particulars of a case by *Mr W. Brown* of this city, where a dose of four grains and a-half, taken by an adult along with nine grains of camphor, was followed by the usual signs of narcotism, and death in nine hours. The man took the opium for a cough at seven in the morning; at nine his wife found him in a deep sleep, from which she could not rouse him; nothing was done for his relief till three in the afternon, when Mr Brown was called to him and found him labouring under all the usual symptoms of poisoning with opium, contracted pupils among the rest; and death ensued in an hour, notwithstanding the active employment of remedies. On examining the body no morbid appearance was found of any note except fluidity of the blood,—a common appearance in cases of poisoning with opium.

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[*] Aufsätze und Beobachtungen. i. 93.

[†] Mém. de l'Acad. des Sciences, xxxviii. 1735.

[‡] Toxicol. Générale from Bibliothèque Médicale, Aout 1806.

[§] *Corvisart's* Journal de Médécine, iv. 3.

[‖] Nouveaux Elémens de Therapeutique, ii. 60.

[¶] London Med. and Phys. Journal, xxviii. 81. This patient took at 4 A. M. 2 ounces of wine of opium, became drowsy at 6, was capable of being roused at 9, vomited by emetics a liquid coloured with laudanum, and was kept awake for the rest of the day. But at 7 P. M. having previously had cough and brown sputa from vinegar entering his windpipe, he became gradually more and more insensible, till at last he was quite comatose; and in this state he continued till his death on the evening of the third day. On dissection nothing was found in the brain or stomach attributable to opium.

[**] London Med. and Phys. Journal, xxxi. 468.

It is more important than may at first sight be imagined to acquire an approximative knowledge of the smallest fatal dose. For, in consequence of the dread entertained by many unprofessional persons of this drug, it is currently believed to be much more active than it is in reality; and instances of natural death have been consequently imputed to medicinal doses taken fortuitously a short time before. The facts stated above comprehend the only precise information I have been able to collect as to the smallest fatal doses in adults. I may add some farther observations, however, on the smallest fatal doses in children. It appears that very young children are often peculiarly sensible to the poisonous action of opium, so that it is scarcely possible to use the most insignificant doses with safety. *Sundeling* states in general terms that extremely small doses are very dangerous to infants on account of the rapidity of absorption. This opinion, which I have heard stated by various practitioners, is amply supported by the following cases.—An infant three days old got by mistake about the fourth part of a mixture containing ten drops of laudanum. No medical man was called for eleven hours. At that time there was great somnolency and feebleness, but the child could be roused. The breathing being very slow, artificial respiration was resorted to, but without advantage: The child died in twenty-four hours, the character of the symptoms remaining unchanged till the last. At the inspection of the body, which I witnessed, no morbid appearance was found.—Similar to this was a case communicated to me by *Dr Simson* of this city, where the administration of three drops of laudanum in a chalk mixture for diarrhœa to a stout child fourteen months old was followed by coma, convulsions, and death in about six hours. Dr Simson satisfied himself, as far as that was possible, that the apothecary who made up the mixture did not commit a mistake.—My colleague, *Dr Alison*, tells me he has met with a case where an infant a few weeks old died with all the symptoms of poisoning with opium after receiving four drops of laudanum, and that he has repeatedly seen unpleasantly deep sleep induced by only two drops.—These remarks being kept in view, it will, I suspect, be difficult to go along with an opinion against poisoning expressed by a German medico-legal physician in the following circumstances. A child's maid, pursuant to a common but dangerous custom among nurses, gave a healthy infant, four weeks old, an anodyne draught to quiet its screams. The infant soon fell fast asleep, but died comatose in twelve hours. There was not any appearance of note in the dead body; and the child was therefore universally thought to have been killed by the draught. But the inspecting physician declared this to be impossible as the draught contained only an an eighth of a grain of opium and as much hyoscyamus *. In the first edition of this work an opinion was expressed to the same purport. But the facts stated above throw doubt on its accuracy, and rather show that the dose was sufficient in the circumstances to occasion death.

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[*] Aufsätze und Beobachtungen, i. 85.

[†] Mémoires de l'Institut—Sc. Physiques, ii. 107.

[‡] Practisches Handbuch für Physiker, iii. 329.

[§] Paris and Fonblanque's Medical Jurisprudence, ii. 388.

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* Pyl's Repert. für die gerichtl. Arzneiwissenschaft, iii. 145.

It is scarcely necessary to add, that the dose required to prove fatal is very much altered by habit. Those who have been accustomed to eat opium are obliged gradually to increase the dose, otherwise its usual effects are not produced. Some extraordinary, but I believe correct information on this subject is contained in the confessions of an English Opium-eater. The author took at one time 8000 drops daily, or about nine ounces of laudanum.

An important topic relative to the effects of opium on man is its operation on the body when used continuously in the manner practised by opium-eaters. This subject was brought forcibly under my notice in 1831 in consequence of a remarkable Civil Trial, in which I was concerned as a medical witness,—that of Sir W. Forbes and Company against the Edinburgh Life Assurance Company. The late Earl of Mar effected insurances on his life to a large amount while addicted to the vice of opium-eating, which was not made known at the time to the insurance company; and he died two years afterwards of jaundice and dropsy. The company refused payment, on the ground that his Lordship had concealed from them a habit which tends to shorten life ; and Sir W. Forbes and Company's Bank, who held the policy of insurance as security for money lent to the Earl, raised an action to recover payment.

In consequence of inquiries made on this occasion, I became for the first time aware of the frequency of the vice of opium-eating among both the lower orders and the better ranks of society; and at the same time satisfied myself, that the habit is often easily concealed from the most intimate friends,—that physicians even in extensive practice seldom become acquainted with such cases,—that the effects of the habit on the constitution are not always what either professional persons or the unprofessional would expect,—and generally that practitioners and toxicologists possess little or no precise information on the matter. In what is about to be offered on the subject, little perhaps will be done to amend this deficiency; but some facts will be stated which appear to me interesting and novel; and which will probably induce other persons of more experience to contribute their knowledge towards filling up so important a blank in medico-legal toxicology.

The general impression is, that the practice of opium-eating injures the health and shortens life. But the scientific physician in modern times has seen so many proofs of the inaccuracy of popular impressions relative to the operation of various agents on health and longevity [*], that he will not allow himself to be hastily carried along in the present instance by vague general belief. The general conviction of the tendency of opium-eating to shorten life has obviously been derived in part from the injurious effects which opium used medicinally has on the nervous system and functions of the alimentary canal,—partly on the reports of travellers in Turkey and Persia, who have enjoyed opportunities of watching the life and habits of opium-eaters on a great scale. The statements of travellers, however, are so vague that they cannot be turned to use with any confidence in a scientific inquiry. *Chardin*, one of the earliest (1671) and best of the modern travellers in Turkey, merely says the opium-eater becomes rheumatic at fifty, and " never reaches an extreme old age" [†]; and his successors have not been more precise,—no one, so far as I can find, having given information as to the age at which the practice usually proves fatal, or the diseases which it tends to engender. By far the greater number of authorities, however, agree in representing the practice to be hurtful. *Dr Burnes*, so far as I am aware, is the only exception; and his opinion is worthy of notice, because he had ample opportunities of observation during his residence in Cutch and at the Court of Sinde for several years prior to 1831. From what he there witnessed Dr Burnes is inclined to think " it will be found in general that the natives do not suffer much from the use of opium,"—that " this powerful narcotic does not seem to destroy the powers of the body, nor to enervate the mind to the degree that might be imagined" *.

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[*] See, for example, *Parent-Duchâtelet* and *D'Arcet* on the health and longevity of Tobacco-manufacturers and Wood-floaters, in Annales d'Hyg. Publ. et de Méd. Lég. i. 169, and iii. 245.

[†] Voyages en Perse, iii. 93.

The familiar effects of the medicinal use of opium in disordering the nervous system and the digestive functions constitute a better reason, than the loose statements of Eastern travellers, for the popular impression of the danger of its habitual and long-continued use. Yet this consideration ought not to be allowed too much weight; because the functions of the nervous system and of digestion may be deranged by other causes, for example by hysteria, without necessarily and materially shortening life. It is desirable therefore to appeal if possible to precise facts.

Hitherto I have been able to learn the particulars of eleven cases only; but it is singular that the general result of their histories would rather tend to throw doubt over the popular opinion. They are as follows:—1. A lady about thirty in good health has taken it largely for twenty years, having been gradually habituated to it from childhood by the villany of her maid, who gave it frequently to keep her quiet. 2. A female who died of consumption at the age of forty-two, had taken about a drachm of solid opium for ten years, but had given up the practice for three years before her death, and led in other respects a licentious life from an early age. 3. A well-known literary character, about fifty years of age, has taken laudanum for twenty-five years, with occasional short intermissions, and sometimes an enormous quantity, but enjoys tolerable bodily health. 4. A lady, after being in the practice of drinking laudanum for at least twenty years, died at the age of fifty,—of what disease I have been unable to learn. 5. A lady about fifty-five, who enjoys good health, has taken opium many years, and at present uses three ounces of laudanum daily. 6. A lady about sixty gave it up after using it constantly for twenty years, during which she enjoyed good health; and subsequently she resumed it. 7. Lord Mar after using laudanum for thirty years, at times to the amount of two or three ounces daily, died at the age of fifty-seven of jaundice and dropsy; but he was a martyr to rheumatism and besides lived rather freely. 8. A woman, who had been in the practice of taking about two ounces of laudanum daily for very many years, died at the age of sixty

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* Narrative of a Visit to the Court of Sinde, p. 230.

or upwards. 9. An eminent literary character, who died lately about the age of sixty-three was in the practice of drinking laudanum to excess from the age of fifteen; and his daily allowance was sometimes a quart of a mixture consisting of three parts of laudanum and one of alcohol. 10. A lady now alive at the age of seventy-four has taken laudanum in the quantity of half an ounce daily between thirty and forty years. 11. An old woman died not long ago at Leith at the age of eighty, who had taken about half an ounce of laudanum daily for nearly forty years, and enjoyed tolerable health all the time. I may add 12. the case of Visrajee, a celebrated Cutchee chief, mentioned by *Dr Burnes*, who had taken opium largely all his life, and was alive when Dr Burnes drew up his Narrative, at the age of eighty, " paralyzed by years, but his mind unimpaired *.

These facts would certainly tend on the whole rather to show, that the practice of eating opium is not so injurious, and an opium-eater's life not so uninsurable, as is commonly thought; and that an insured person, who did not make known this habit, could scarcely be considered guilty of concealment to the effect of voiding his insurance. But I am far from thinking that the facts now stated can with justice be made use of to support such important inferences; for, with so small a number of cases, it is impossible to keep clear of the fallacy arising from the accidental grouping of similar facts, often remarked in medical experience; besides there is an obvious reason, why in an inquiry of this kind those special cases chiefly should come under notice where the constitution has escaped injury, cases fatal in early life being more apt to be lost sight of or more likely to be concealed; and I therefore certainly expect that a more thorough investigation of the subject will bring to light many instances of the latter description.

Meanwhile, insurance companies and insurance physicians ought to be aware that many persons in the better ranks of life are confirmed opium-eaters without even their intimate friends knowing it. And the reason is, that at the time the opium-eater is visible to his friends, namely during the period of excitement, there is frequently nothing in his behaviour or appearance to attract particular attention. From the information I have received, it appears that the British opium-eater i by no means generally subject to the extraordinary excitemen of mind and body described by travellers as the effect of opium-eating in Turkey and Persia; but that the common effect merely is to remove torpor and sluggishness, and make him in the eyes of his friends an active and conversible man. The prevailing notions of the nature of the excitement from eating opium are therefore very much exaggerated.—Another singular circumstance I have ascertained is, that constipation is by no means a general effect of the continued use of opium. In some of the cases mentioned above no laxatives have been required; and in others a gentle laxative once a week is sufficient.

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* Narrative, &c. p. 231.

In the civil suit regarding Lord Mar's insurances, the insurance company was found not entitled to refuse payment,—not, however, on the ground that the habit of opium-eating is harmless to longevity,—but, I believe, chiefly on a technical ground, implying that they did not make inquiry into his habits with the care usually observed by insurance companies, and were therefore to be understood as accepting the life at a venture. A new trial was granted by the court on a technical ground, but the parties compromised the case. *

The previous remarks on the symptoms of poisoning with opium in man have been confined to its effects when swallowed. But it was mentioned under the head of its mode of action, that this poison has been known to act with energy upon animals through every channel by which it can be introduced into the system. It is natural to expect that the same will be the case with man also.

The only other modes in which poisoning with opium has been produced in man, besides administration by the mouth, have been by injection into the anus, by application to the skin deprived of its cuticle, perhaps even also to the unbroken skin; and a case has been likewise reported of death from its introduction into the external opening of the ear.

In the Journal de Chimie Médicale, an instance is shortly noticed of a lady who was poisoned by the administration of too

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* Edin. Medical and Surgical Journal, xxxvii. 123.

strong an anodyne injection prepared by herself from fresh poppy heads. She recovered [*].

It is generally believed in France that opium acts more energetically through the medium of the rectum, than through the stomach. *Orfila* in particular has endeavoured to establish this by experiments on animals, and quotations from cases recorded by some authors of its action upon man [†]. But neither the experiments nor the quotations appear to me satisfactory; and the rule they go to support is completely at variance with the practice pursued in the medicinal administration of the drug in Britain. It is the custom to give twice as much in an enema as in a draught. I have given by injection, without producing more than the usual somnolency, two drachms by measure of laudanum, a dose which, were Orfila's statement correct, would prove fatal.

As to the action of opium through the skin when deprived of its cuticle, I am not acquainted with any fatal case of the kind, but have no doubt that such may happen. One of my friends very nearly lost his life in the way alluded to. He had applied an opium-poultice to the scrotum to allay the violent irritation caused by a blister, and fell into a state of profound sopor, which was luckily interrupted by a visitor, so that the cause was discovered before it was too late. An instance of the same kind has also been published by *M. Pelletan.* A child two months old very nearly perished in consequence of a cerate containing fifteen drops of laudanum having been kept for twenty-four hours on a slight excoriation produced by a fold of the skin. When the cause of illness was discovered, the child had been for some hours almost completely insensible, with a slow, obscure pulse, and occasional convulsions [‡].

But perhaps opium may in some circumstances act even through the unbroken skin. It has certainly been often applied in this way to relieve local pain without effect. Yet, on the other hand, its effect has been often unequivocal; and the following incident seems to show that it may even prove fatal in certain diseased states of the integuments. A soldier affected with erysipelas of the leg, had a linseed poultice applied, which his surgeon ordered to be sprinkled with 15 drops of laud num. Next morning the patient was found in a state of dee sopor, and affected with convulsive twitches of the muscles the face and limbs; and in no long time he expired. His s porose state turned the surgeon's attention to the poultic which he found coloured yellow and smelling strongly of opiu and on removing it he discovered that it was completely soake with laudanum, which the attendant had carelessly poured o it to the extent of an ounce. The patient died notwithstanding all the remedies which his state called for; and the viscer were found quite healthy; but in many places the blood is sai to have had a strong odour of opium *.

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[*] Journal de Chim. Méd. iii. 24.

[†] Toxicologie Générale, ii. 81, 82.

[‡] Journal de Chim. Méd. vii. 250.

In an instance reported by M. Tournon of Bordeaux, deat is supposed to have arisen from the introduction of opium int the external opening of the ear, as a remedy for ear-ache. I is possible that fatal poisoning may thus be induced by laudanum too freely and frequently renewed: But it seems very unlikely that death was owing to opium in the instance in question, since it was used in the solid form, and in the quantity o four grains; so that the dose was small, and absorption mus have been very slow. The account merely states that the patient fell asleep, but his sleep was that of death †.

Of the Action of Morphia, Narcotine, Codeïne, and Meconic Acid

The mode of action and the symptoms of the two active principles of opium, Morphia and Narcotine, have been examined by many experimentalists.

The action of *Morphia* is nearly the same as that of opium; but more energetic. In its solid state it has little effect, being nearly insoluble. But when dissolved in olive oil, or in alcohol, or in the acids, particularly the acetic, it excites in animals the same symptoms as opium. Experimentalists are not yet agreed as to its power. The trial of Castaing gave rise to a physiological inquiry by three French physicians, *Deguise*, *Dupuy*, and *Leuret*, who assigned to it feeble properties; but more reliance is usually placed in the experiments of *Orfila*, who found that one part of morphia was equal in energy to two parts of the watery extract, and to four parts of crude opium. The observations I have made on the medicinal effects of morphia and its muriate, lead me to believe that half a grain is fully equal in power to two or perhaps three grains of the best Turkey-opium. Probably those who have observed but slight effects from it have accidentally used narcotine instead of it; for I know they are often confounded together, and have reason even to suspect that a good deal of narcotine is ignorantly thrown into commerce as morphia.

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* Journal de Chimie Médicale, Avril 1827, and Edin. Med. Journ. xxix. 450.

† Ibidem, vii. 114.

On man morphia acts like opium; it produces somnolency. It was at one time thought that in medicinal doses it does not produce either the disagreeable subsequent or the idiosyncratic effects of opium; *Magendie* has made some observations to this purport [*]; and *Dr Quadri* of Naples has been led to the same conclusion by his experience [†]. Others, however, have doubted the accuracy of these authors, and opposite results appear to have been procured by some. My own experience with the muriate of morphia inclines me to concur in opinion with Magendie and Quadri.

The effects of morphia on man in fatal doses have hitherto been observed in a few cases only. The first which may be mentioned is that of a young Parisian graduate, who swallowed twenty-two grains for the purpose of self-destruction. In ten minutes he felt heat in the stomach and hindhead, with excessive itchiness; in three hours and a-half he had also a sense of pricking in the eyes, with dimness of vision; in an hour more he for the first time felt approaching stupor. Half an hour afterwards, when the people of the house came into his room to learn why he lay so long in bed, he could not see them, though he was sensible enough to be able to reply to their inquiries, that he lay in bed because he had not slept the night before. Soon after this he fell into a state of profound stupor and lost all consciousness. In thirteen hours he was visited by *Orfila*, who found him cold, quite comatose, and affected with locked-jaw; the pupils were feebly dilated, the pulse 120, the breathing hurried and stertorous, the belly tense and tympanitic; and there were occasional convulsions, with intense itching of the skin. By means of copious venesection, sinapisms, ammoniated friction, stimulant clysters, ice on the hea and acidulous drinks, he was gradually roused, so that in hours he recognized Professor Orfila. In the subsequent nig and following day he had difficult and scanty micturition, wi pain in the kidneys and bladder, and difficulty in swallowin but these symptoms went off during the second night; and the third morning he was quite well [*]. The itching of t skin remarked in this case is considered by *M. Bally* an invariable symptom of the operation of morphia even in medicin doses [†]. It is not, however, always produced.

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[*] Bulletins de la Société Philomatique, 1818, p. 54.—Journal de Chimie Médicale, Avril 1827.

[†] Annali Universali di Med. xxxi. 169, xxxiv. 100.

Another case, which occurred at Lunéville, is very remarkable in its circumstances. A young man addicted to opium-eating, but who had left off the practice for a twelvemonth, too first ten grains, and in ten minutes forty grains more of acetat of morphia. In five minutes he had excessive general feebleness and a sense of impending dissolution, which forced him t confess what he had done. In fifteen minutes more *M. Castara* who describes the particulars, found him motionless, almost comatose, and breathing laboriously. The limbs were flaccid, th pupils contracted, the face and lips livid, the skin warm and moist, the pulse full and hard, and deglutition impossible. Tartar-emetic was ordered, but could not be administered. He was then bled at the arm to eighteen ounces; upon which he started as from sleep, rubbed his eyes, said every thing turned round him, and that he could not see the people present. When left to himself he quickly fell into a calm slumber, but if kept awake he told collectedly all that happened before he became comatose. He complained chiefly of intense itching and a general sense of bruising. In an hour, by keeping him constantly roused, his consciousness was almost restored, and this without vomiting having been produced, though two grains of tartar-emetic had been swallowed and three administered by the rectum. In four hours after he swallowed the poison he vomited freely and had diarrhœa. After this he steadily recovered, the sleepiness continuing all next day, and the itching of the skin even longer [‡].

M. Julia-Fontenelle met with a case of poisoning with this alkaloid in consequence of its having been administered with a clyster in the form of sulphate. The subject was a child, five years old, the dose five grains, the symptoms those of apoplexy, and death supervened within twenty-four hours [*].

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[*] Journal de Chim. Méd. v. 410.

[†] Mém. de la Soc. Roy. de Médecine, i. 142.

[‡] Journal de Chim. Méd. vii. 135.

The only other case yet on record is that of the French gentleman who was supposed to have been poisoned by Dr Castaing; and it is not a pure one, for besides the symptoms of a consumptive complaint under which he had laboured for some time, there were circumstances in his last illness which indicated the administration of other deleterious substances. About thirty-six hours before his death, however, they were exactly such as might be expected from a large dose of morphia. About five minutes after the administration of a draught by the prisoner, the gentleman was attacked with convulsions, and not long afterwards his physician found him quite insensible, unable to swallow, bathed in a cold sweat, with a small pulse, a burning skin, the jaws locked, the neck rigid, the belly tense, and the limbs affected by spasmodic convulsions. In this state he seems to have continued till his death. The only appearances found in the dead body, which bore any relation to the poison suspected, were congestion of blood and serous effusion in the vessels of the cerebral membranes. If morphia was the cause of death, it is highly probable that, besides what was administered thirty-six hours before he died, several doses were given subsequently: otherwise, from what is known of the action of opium, the narcotism could scarcely have lasted uninterruptedly for so long a period [†].

For the following extraordinary case I am indebted to one of my pupils, Mr Clark of Montrose: A woman took one morning by mistake ten grains of very pure muriate of morphia, which had been prepared not long before by Mr Clark in my laboratory, and was freed of codeïne. The mistake having been discovered almost immediately, means were taken to prevent any ill effects from the accident, and within half an hour after the poison was swallowed the stomach was completely cleared by the stomach-pump. At this time she was quite sensible. But stupor quickly came on after the poison was evacuated, and deep imperturbable coma gradually formed, so that nothing could rouse her in the slightest degree except cold affusion of the head and chest, which caused faint signs of returning consciou ness. Before night she expired, though all the usual remedi were resorted to. An inspection of the body was not obtaine which is much to be regretted, since without it the case is qui obscure. I do not know a single instance of fatal coma fro opium where the proper remedies were resorted to before t stupor commenced; and death in such circumstances is so i conceivable, that we must ascribe the result in this case apoplexy either incidentally concurring, or brought on by t operation of the poison.

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[*] Revue Médicale, 1829, iii. 424.

[†] Procès Complet d'Edme-Samuel Castaing, p. 31.

The effects of *Narcotine* have been examined experimentall by Magendie and Orfila; but their results do not coincide. A cording to *Orfila* it is not easy to poison dogs with it, as it e cites vomiting and is discharged. But when the gullet is tie the animal dies in two, three, or four days without any remar able symptom but languor and hard breathing [*]. In these e periments it was dissolved in olive oil; it does not act at all i the solid state. *Magendie* found that it produces in dogs a stat like reverie, accompanied with convulsions. They lie still e cept when convulsed, and are apparently asleep or dreaming but they are really alive to external objects, and even in a stat of acute irritability. In short, he considers the symptoms t constitute an aggravated form of the subsequent and idiosyncratic effects caused by opium on man. Vinegar, he says, destroys altogether the poisonous properties of narcotine. According to Orfila it only weakens them. Muriatic acid woul seem to annihilate them entirely; for *Orfila* found no effect i dogs from forty grains dissolved in water with the aid of muriatic acid; and *Bally* gave sixty grains in like manner to a patient without injury [†]. Forty grains dissolved by sulphuri acid proved fatal to a dog in twenty-four hours [‡].

Narcotine, like other narcotic poisons, is more powerful whe introduced at once into the blood, but produces nearly the sam effects as when it is swallowed. *Orfila* found that a single grai was as powerful through the former, as eight grains throug the latter channel [§]. *Dieffenbach* observed that half a grain dissolved in water by means of a drop or two of hydrochloric acid killed cats in five minutes when injected into a vein, and always produced congestion within the head, and extravasation on the surface of the cerebellum. A remarkable circumstance observed in the course of his experiments was, that leeches applied to a rabbit under the influence of narcotine died immediately in convulsions; and that a portion of the blood of the same rabbit when injected into the vein of another produced drowsiness, languor, and pandiculation for nearly a-day *.

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[*] Toxicol. Générale, ii. 70.

[†] Traité de Médecine Légale, iii. 353.

[‡] Ibidem, iii. 356.

[§] Toxicol. Générale, ii. 70.

The effects of narcotine on man have not been much inquired into. From the only researches on the subject I have yet seen, those of *Dr Wibmer* of Munich, it appears to be but a feeble poison. He found by experiment on himself, that two grains dissolved in olive oil produced merely slight transient headach; that eight grains dissolved by means of muriatic acid had no effect at all; and that the same quantity of solid narcotine occasioned temporary headach, and in twenty-eight hours a singular state of excitement, with trembling of the hands, restlessness, and inability to fix the thoughts on any object. These effects went off in a few hours †.

The effects of *Codeïne* have been examined by *Dr Kunkel.* He found that twelve grains dissolved in water and introduced into the stomach killed a rabbit in three minutes; that six grains in solution when injected into the cellular tissue occasioned death in little more than two hours; that the same quantity administered by the mouth sometimes had little effect; that when given in powder its action was very feeble; and that the symptoms were excitement of the pulse, convulsions, and tetanus, without any tendency to sopor or somnolency ‡. Hence codeïne is conceived to be a stimulant of the nervous system, and consequently the cause of the excitant effects sometimes produced by opium. It may be doubted, however, whether its proportion in opium is sufficient for explaining these effects.

Meconic acid is inert. *Sertuerner*, indeed, thought the meconate of soda acted as a powerful poison in some experiments made on himself and on dogs; but more careful researches have since proved that he was misled by some error. *Sömmering* found that ten grains of meconic acid or meconate of soda ha no effect whatever on dogs [*]. Subsequently, in consequen of two people having died suddenly at Turin after taking eac a grain of the acid, some careful experiments were made b *Drs Feneglio* and *Blengini*, who gave eight grains to dog crows, and frogs, and four grains to various men, without re marking any injurious effects whatever [†].

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* *Meckel's* Archiv für Anat. und Physiol. xiv. 19.

† *Buchner's* Repertorium für die Pharmacie, xxxvi. 204.

‡ Journal de Chim. Méd. ix. 223.

The *Distilled Water* of opium has been considered by som physiologists an active poison; but *Orfila* has found it to b nearly, or altogether inert. Two pounds introduced into th stomach of a dog, and two ounces and a-half injected into a vein had no effect whatever [‡].

SECTION III.—*Of the Morbid Appearances caused by Opium.*

In discussing this subject the appearances in the best marke cases will be first noticed; and then some account will be give of the variations to which they are liable.

In *Knape's* Annals there is a very good example of the mos aggravated state of the appearances left by opium. It is th case of an infant who was killed in the course of a night by a decoction of poppy-heads. There was a great deal of livo over the whole back part of the body. All the sinuses and vessels of the brain were gorged with fluid blood; and a good deal of serosity was found in the ventricles and base of the skull. The pharynx was red. The lungs were distended, and so gorged with fluid blood, that it ran out in a stream when they were cut. The cavities of the heart contained the same fluid blood. There was some redness in the villous coat of the stomach and intestines; and poppy-seeds were found in the stomach. Although the body had been kept only two days in the month of February, the belly emitted a putrid odour when it was laid open [§].

In commenting upon these appearances, it may be first remarked, that turgescence of the vessels in the brain, and watery effusion into the ventricles, and on the surface of the brain, are generally met with. *Dr Bright* mentions an instance where unusual turgescence was found, and on the surface of the brain a spot of slight ecchymosis as big as a crown-piece*. I have seen turgescence of vessels and serous effusion in one instance to a considerable extent: Each ventricle contained three drachms of fluid, the arachnoid membrane on the surface of the brain was much infiltered, and the vessels both in the substance and on the surface of the brain were a good deal gorged with blood. But congestion and effusion are by no means universal: in a case I examined judicially in November 1822, which proved fatal in about seven hours, there was neither unusual congestion nor effusion.—In the remarks on the diseased appearances caused by the narcotics generally, it was observed that extravasation of blood is a very rare effect of opium. The only good example of the kind I have seen is related by *Mr Jewel* of London. It was the case of a young married female, who died eight hours after taking two ounces of laudanum. Several clots were found in the substance of the brain, and one, which lay in the anterior right lobe, was an inch long †. There is little doubt that poisoning with opium may cause extravasation, by developing a disposition to apoplexy; but considering the very great rarity of this appearance in persons killed by opium, it may reasonably be questioned whether extravasation can be produced without some such predisposition co-operating.

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[*] *Buchner's* Toxikologie, p. 208.

[†] *Henke's* Zeitschrift für die Staatsarzneikunde, xiv. 456.

[‡] Toxicologie Générale, ii. 86.

[§] Krit. Annalen der Staatsarzn. I. iii. 501.

The lungs are sometimes found gorged with blood, as in many cases of apoplexy. They were so in the soldier mentioned in the Journal Universel, who died in convulsions. They were in the same state in a patient of my colleague *Dr Home*, a man who died in the clinical ward here in 1825, four hours after taking two ounces of laudanum in six ounces of whisky; and likewise in the case quoted from *Pyl*, in which sixty grains of solid opium were taken. But this appearance is not more constant than congestion in the brain. *Orfila* never found it in dogs, and in three cases I have examined the lungs were perfectly natural. Perhaps they are more usually turgid when death is preceded by convulsions. They were particularly so in the case of the soldier above-mentioned, and likewise in another case of the same nature recorded in *Rust's* Magazin ‡.

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* Reports of Medical Cases, ii. 203.

† Lond. Med. and Phys. Journal, Feb. 1816.

‡ Magazin für die Gesammte Heilkunde, xvii. 121.

The stomach, as in *Knape's* case, is occasionally red, and in the woman mentioned by *Lassus*, who died after swallowing thirty-six grains, it is said to have been inflamed. But even redness is rare, and decided inflammation probably never occurs. In four cases I have examined, the villous coat was quite healthy; and it was equally so in another related in Knape and Hecker's Register *.

Lividity of the skin is almost always present more or less, and sometimes it is excessive. In one of the cases I examined it was universal over the depending surface of the body.

It has been said that the blood is always fluid. This certainly appears to be very generally the case. For example, the blood was fluid in the case of the soldier who died in convulsions, in Dr Home's patient, in four adults I have examined, and likewise in Pyl's case. But at the same time this condition of the blood is not invariable: In the case related in Knape and Hecker's Register, it was coagulated in the left cavities of the heart; in another related by *Petit* in Corvisart's Journal, there were clots in both ventricles †; and in the case of the first infant mentioned in page 658, clots were also found in both ventricles. In Alibert's case, a large fibrinous concretion was found in the heart, clearly showing that the blood had coagulated after death as usual.

It appears that the body is often apt to pass rapidly into putrefaction. In one of the cases I examined, although the body had been kept only thirty hours in a cool place in the month of December, the cuticle was easily peeled off, the joints were flaccid, and an acid smell was exhaled. In Réaumur's case, that of a young man who died in fifteen hours, in consequence of his companions in a drunken frolic having mixed a drachm of opium in his wine, the body soon became covered with large blue stains, and gave out an insupportable odour. A French physician has related in the Journal de Médecine a still more pointed case of a lady who died seven hours after taking a large quantity of laudanum by mistake, and whose body was so far gone in putrefaction fourteen hours after death, that the dissection could not be delayed any longer. The hair and cuticle separated on the slightest friction, and the stomach, intestines, and large vessels were distended with air *.

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* Kritische Jahrbücher, ii. 100. When inflammation is found it is not improbably owing to irritants given to produce vomiting, but failing to act. This was apparently the cause in a case described by *Mr Stanley*, Trans. London Coll. of Phys. vi. 414.

† Journ. de Méd. xxxiv. 267.

It is doubtful whether this is a constant appearance or not. In one case I examined, the body was free from putrefaction forty-eight hours after death.

Although opium is generally believed to suspend all the secretions and excretions but the sweat, instances have been met with where a great collection of urine was found in the bladder after death. In a paper on the signs of death by opium, in Augustin's Repertorium, it is stated that *Welper* of Berlin always found the bladder full of urine, and the kidneys gorged with blood, both in man and animals †. I am not prepared to say how far this is a common condition, as the state of the urinary organs is seldom noticed in published cases.

In the examination of the dead body unequivocal evidence will sometimes be procured by the discovery of a portion of the poison in the stomach. But it must not always be concluded that opium has not been swallowed, because the sense of smell, chemical analysis, and experiments on animals fail to detect it. For, as was already remarked, the opium may not remain in the stomach after death, though a large quantity was swallowed, and not vomited. This may arise from two causes. It may be all absorbed, as will often happen when it has been taken in the liquid form: or it may be partly absorbed and partly decomposed by the process of digestion. But in one or other of these ways it may certainly disappear, and that in a very few hours only. Several instances to this effect have been already mentioned, (p. 59, 641, 642). These remarks are important, because the fact is generally believed to be the reverse; and *Dr Paris*, in his work on Medical Jurisprudence, has tended to propagate the misconception, by asserting that in all fatal cases opium may be detected in the stomach ‡.

At the same time there is no doubt that the poison may sometimes be found in the stomach. In Knape and Hecker's Register there is the case of a girl who died about eight hours after taking half an ounce of laudanum; and the reporters foun that an extract prepared from the contents of the stomach cause deep sleep in frogs, chickens, and dogs, and threw some o them into a comatose state, which proved fatal [*]. *Wildberg* ha related a very interesting case of a young lady of Berlin, who had been seduced, and finding herself pregnant, swallowed about half an ounce of laudanum in the evening, and died during the night. In this instance the contents of the stomach had a narcotic odour, and their extract when given to a young dog caused excessive sleep, reeling, palsy of the legs, convulsions and death [†]. *M. Petit* has related another case fatal in about ten hours, where the contents of the stomach had the smell of opium; and their alcoholic extract had a bitter taste, and killed guinea-pigs with symptoms of narcotism [‡]. In a case related by *Mayer* in Rust's Magazin, which proved fatal after so long an interval as ten hours, the poison, which in this instance was the saffron-tincture, was distinctly detected in the stomach by a strong odour of opium and saffron [§]. Lastly, in a case where the patient lived between thirteen and fourteen hours, that of the individual for whose murder Stewart and his wife were lately executed at Edinburgh, *Dr Ure* succeeded in detecting meconic acid in the contents of the stomach, which had been removed by the pump about three hours after the opium was swallowed [‖].

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* The reference to this case has been lost.

† *Augustin's* Repertorium, i. 2, 12.

‡ Medical Jurisprudence, ii. 394.

An important fact, ascertained by *MM. Orfila* and *Lesueur*, is that neither opium nor the salts of morphia undergo decomposition by being long in contact with decaying animal matter. Even after many months they may be discovered; at least the putrefaction of the matter with which they are mingled does not add any impediment in the way of their discovery. It is only necessary to observe that the alkaloid may be rendered insoluble by the evolution of ammonia, which separates it from its state of combination [¶].

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[*] Kritische Jahrbücher, ii. 100.

[†] Praktisches Handbuch für Physiker, iii. 331.

[‡] *Corvisart's* Journal de Médecine, xxxiv. 263.

[§] Magazin für die gesammte Heilkunde, iii. 24.

[‖] Oral evidence at the Trial, also London Journal of Science, N. S. vi. 56.

[¶] Revue Médicale, 1828, ii. 473, 475.

Section IV.—*Of the Treatment of Poisoning with Opium.*

The treatment of poisoning with opium, owing partly to the numerous cases that have been published, and partly to the experiments of Orfila on the supposed antidotes,—is now well understood.

The primary object is to remove the poison from the stomach. This is proper even in the rare cases in which vomiting takes place spontaneously. It is by no means easy to remove all the opium by vomiting, especially if it is taken in the solid state; for it becomes so intimately mixed with the lining mucus of the villous coat, that it is never thoroughly removed till the mucus is also removed, which is always with difficulty effected.

The removal of the poison is to be accomplished in one of three ways, by emetics administered in the usual manner, by the stomach-pump, or by the injection of emetics into the veins.

By far the best emetic is the *Sulphate of Zinc* in the dose of half a drachm or two scruples, which may be repeated after a short interval, if the first dose fails to act. In order to insure its action it is of great use to keep the patient roused as much as possible,—a point which is often forgotten.—The *Sulphate of Copper* has been used by some as an emetic; but it is by no means so certain as the sulphate of zinc. Besides, as it is a much more virulent poison, it may prove injurious, if retained long in the stomach. In Dr Marcet's case the patient, after recovering from the lethargic symptoms, suffered much from pain in the throat and stomach, occasioned probably by the sulphate of copper which he took remaining some time undischarged.—*Tartar Emetic*, from the uncertainty of its action when given in considerable doses, is even worse adapted for such cases. This is illustrated by a case in the seventh volume of the Medical and Surgical Journal, the same which has already been referred to as exemplifying the occasional occurrence of convulsions and delirium in poisoning with opium. A scruple of tartar emetic was administered to cause vomiting, but to no purpose. When it had remained fifteen minutes, sulphate of zinc was also given, and with immediate effect. But the patient after recovering from the sopor was attacked with pains in the stomach and bowels, and with tenesmus, which lasted several days.

Emetics should be preferred for removing the poison from the stomach, provided the case be not urgent. Even then, however, they sometimes fail altogether. The best practice in that case is to endeavour to remove the poison with the stomach-pump; and this in urgent cases should be the first remedy employed. The treatment by the stomach-pump has now become so generally known, that it is unnecessary to describe it particularly. It was recommended in this country by the late Dr Monro in his lectures; but does not appear to have been tried by him. In 1803 it was first published by *Renault* in his treatise on the counter-poisons of arsenic; and he had tried it on animals [*]. But the first person who used it in an actual case of poisoning with opium was *Dr Physick* of Philadelphia. He saved the life of a child with it in 1812; and not long afterwards his countryman, *Dr Dorsey*, cured two other individuals [†]. More lately it was again proposed in London by *Mr Jukes*, who does not appear to have been acquainted with these prior trials and experiments. He cannot of course be considered in the light of a discoverer; but the profession is much indebted to him for having recalled their attention to this treatment, and for having by his success and activity fairly established its reputation. An account will be seen of his apparatus and of several cases in the Medical and Physical Journal for September and November 1822.—In using the stomach-pump care must be taken not to injure the stomach by too forcible suction.—When it is not at hand, *Mr Bryce* of this city recommended the substitution of a long tube with a bladder attached. After the stomach has been filled with warm water from the bladder, the tube is to be turned down so as to act upon the contents of the stomach as a syphon. *Dr Alison* cured a clinical patient in this way [‡].

Another method of removing opium from the stomach, which has been practised successfully where the patient could not be made to submit to the common treatment, is the injection of tartar-emetic into the rectum. A case is related by *Dr Roe* of New York where this treatment proved successful. Fifteen grains in half a gallon of water excited free vomiting, and ten grains more renewed it. Care was taken to insure the discharge of the whole tartar-emetic by a subsequent purgative injection[*].

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[*] Sur les Contrepoisons de l'Arsenic, 93.

[†] *Beck's* Medical Jurisprudence, 435.

[‡] Edin. Med. and Surg. Journal, xxiii. 416.

The last method for removing opium from the stomach is a desperate one, which can only be recommended when emetics by the mouth have utterly failed, and when a stomach-pump, or Mr Bryce's substitute, cannot be procured. It is the injection of an emetic into the veins. Tartar-emetic answers best for this purpose, and its effect is almost certain. A grain is the dose. While injecting it care must be taken by the operator not to introduce air into the vein.

The next object in conducting the treatment of poisoning with opium is to keep the patient constantly roused. This alone is sufficient when the dose is not large, and the poison has been discharged by vomiting; and in every case it forms, next to the evacuation of the stomach, the most important part of the treatment.

The best method of keeping the patient roused is to drag him up and down between two men, who must be cautioned against yielding to his importunate entreaties and occasional struggles to get free and rest himself. For the sopor returns so rapidly, that I have known a patient answer two or three short questions quite correctly on being allowed to stand still, and suddenly drop the head in a state of insensibility while standing. The duration of the exercise should vary according to circumstances from three, or six, to twelve hours. When he is allowed at length to take out his sleep, the attendants must ascertain that it is safe to do so by rousing him from time to time; and if this should become difficult, he must be turned out of bed again and exercised as before.

It appears from some cases published not long ago by *Mr Wray*[†] and *Dr Copland*[‡], and more lately also by *Dr Bright*[§], that the most insensible may be roused to a state of almost complete consciousness for a short time, by dashing cold water over the head and breast. This treatment can never supersede the use of emetics; and as its effect is but temporary, it ought not to supersede the plan of forced exercise. But it appears to be an excellent way to insure the operation of emetics. If the emetic is about to fail in its effect, cold water dashed over the head restores the patient for a few moments to sensibility, during the continuance of which the emetic operates. Dashing cold water over the head may perhaps be dangerous in the advanced stage, when the body is cold and the breathing imperceptible; but the most desperate remedies may be then tried, as the patient is generally in almost a hopeless state. In one of the cases mentioned by *Dr Bright* from the experience of Mr Walne, complete recovery was accomplished, mainly by cold affusion of the head, where there appeared reason to believe that more than an ounce and a-half of laudanum had disappeared from the stomach before evacuating remedies were used.—This treatment seems to have been first proposed in 1767 by a German physician, *Dr Gräter* [*].

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[*] American Journal of the Med. Sciences, vii. 555.

[†] London Med. Repository, xviii. 26.

[‡] London Med. and Phys. Journal, xlviii. 225.

[§] Reports of Medical Cases, ii. 208.

In some cases internal stimulants have been given with advantage, such as assafœtida, ammonia, camphor, musk, &c. It is always useful to stimulate the nostrils from time to time, by tickling them, or holding ammonia under the nose; but the application should be neither frequent nor long-continued, as the ammonia may cause deleterious effects when too freely inhaled. Pulling the hair and injecting water into the ears are also powerful modes of rousing the patient.

Venesection has been recommended and successfully used by some physicians. If the stomach be emptied, and the patient kept roused, as may almost always be done when means are resorted to in time, venesection will be unnecessary. Sometimes, however, when the pulse is full and strong it may be prudent to withdraw blood; and it certainly appears that in most cases where this remedy has been employed the sensibility began to return almost immediately after. This is very well shown in a case of poisoning with opium related by *Mr Ross* [†] in the Edinburgh Medical Journal, in another described in the same Journal by Mr Richardson [‡], and also in the two cases of poisoning with acetate of morphia mentioned in a former page. In some cases, on the contrary, it has seemed injurious, probably because it was not had recourse to till the patient was moribund. It is a sound general rule that blood-letting ought not to be resorted to till the poison is thoroughly removed from the stomach; for it favours absorption. And yet facts are not wanting to show that this rule, now generally admitted since the researches of *Magendie* on absorption, is not infallible. *Dr Young* of the United States has given the particulars of a case where imperturbable coma was formed, together with puffing, stertorous respiration, in consequence of an ounce of laudanum having been swallowed,—and where recovery took place, without the poison having been removed at all, simply under the employment of three blood-lettings to the conjunct amount of twenty-eight ounces, of cold to the head, and of sinapisms to the legs *.

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[*] Diss. Inaug. De Venenis in genere. Argentorati, 1767, quoted by *Marx*, die Lehre von den Giften, I. ii. 237.

[†] Edin. Med. and Surg. Journal, xix. 247.

[‡] Ibidem, xvii. 226.

In desperate circumstances Artificial Respiration may be used with propriety. After the breathing has been almost or entirely suspended the heart continues to beat for some time; and so long as its contractions continue, there is some hope that life may be preserved. But it is essential for the continuance of the heart's action, that the breathing be speedily restored to a state of much greater perfection than that which attends the close of poisoning with opium. It is not improbable that the only ultimate cause of death from opium is suspension of the respiration, and that if it could be maintained artificially so as to resemble exactly the natural breathing, the poison in the blood would be at length decomposed and consciousness gradually restored. The following is an interesting example by *Mr Whateley*, in which artificial respiration proved successful. A middle-aged man swallowed half an ounce of crude opium and soon became lethargic. He was roused from this state by appropriate remedies, and his surgeon left him. But the poison not having been sufficiently discharged, he fell again into a state of stupor; and when the surgeon returned, he found the face pale, cold and deadly, the lips black, the eyelids motionless, so as to remain in any position in which they were placed, the pulse very small and irregular, and the respiration quite extinct. The chest was immediately inflated by artificial means, and when this had been persevered in for seve minutes, expiration became accompanied with a croak, whic gradually increased in strength till natural breathing was established. Emetics were then given, and the patient eventuall recovered[*]. *Dr Ware* of Boston (U. S.) has more lately described another case, where artificial respiration was employe with marked advantage, and would probably have saved th patient's life in very unpromising circumstances, but for th disease on account of which the opium was given[†].

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* London Medical Gazette, xiv. 655.

It would be a fruitless task to examine into the merits of the numerous antidotes, which have from time to time been proposed for poisoning with opium. *Professor Orfila* has examined many of them with great care, such as vinegar, tartaric acid, lemonade, infusion of coffee, decoction of galls, solution of chlorine, camphor, diluents; and he has found them all useless before the poison is expelled from the stomach, with the single exception of decoction of galls. As he remarked that this fluid throws down the active principles of an infusion of opium, and subsequently found that such a mixture acts more feebly on the animal system than the opiate infusion itself, he thinks the decoction of galls may with propriety be used as an imperfect antidote till the poison can be evacuated from the stomach[‡]. His experiments, however, do not assign to it very material activity as a remedy; and certainly the whole efforts of the physician ought in the first instance to be directed to the removal of the opium and to keeping the patient roused. When the opium has been completely removed, the vegetable acids and infusion of coffee have been found useful in reviving the patient, and subsequently in subduing sickness, vomiting, and headach; but till the poison is completely removed the administration of acids is worse than useless, provided the opium was given in the solid state, because its solution in the juices of the stomach is accelerated. It has been recently stated that Iodine, Chlorine, and Bromine are all antidotes for poisoning with the vegetable alkaloids[§]. Some notice will be taken of this statement in the Chapter on Nux Vomica.

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[*] London Med. Obs. and Inq. vi. 331.

[†] North American Med. and Surg. Journal, July 1826.

[‡] Toxicol. Gén. ii. 110.

[§] Le Globe, vii. 525. *Août* 1829.

CHAPTER XXVIII.

OF POISONING WITH HYOSCYAMUS, LACTUCA, AND SOLANUM.

Of Poisoning with Hyoscyamus.—Of the Narcotic Poisons none bears so close a resemblance to opium in its properties as the *Hyoscyamus* or Henbane. Several species are poisonous; but the only one that has been examined with care is the *H. niger*, from which the common extract of the apothecary is prepared.

The Hyoscyamus has been analyzed by various chemists, and found to contain a peculiar alkaloid, in which the properties of the plant are concentrated. It is named Hyoscyamia. Considerable obscurity has for some time hung over the nature and properties of this substance; but very lately the pure principle seems to have been detached by *MM. Geiger* and *Hesse*. Some years ago *Brandes* obtained an impure substance possessing active properties *. More lately he separated by distillation with caustic potass or lime an oily-like substance, colourless and transparent, of a penetrating, repulsive odour and acrid taste, volatile considerably above 212°, sparingly soluble in water, freely so in alcohol and ether, capable of uniting with acids and forming with them sometimes crystalline salts. This he considered pure hyoscyamia †.

In a paper recently published, however, by *MM. Geiger* and *Hesse* on the composition of the natural family Solaneæ, it is shown that pure hyoscyamia is a solid body, in fine silky crystals, without odour, of a strong acrid taste like tobacco, partially volatilizable with boiling water, entirely volatilizable alone at a somewhat higher heat, undergoing decomposition and giving off ammonia when heated with solution of caustic potass, very soluble in alcohol and ether, but sparingly so in water ‡. The relation of the oleaginous principle of Brandes to the crystalline hyoscyamia of Geiger and Hesse has not been determined.

Farther, hyoscyamus, like many other narcotic vegetables, stramonium, digitalis, opium, tobacco, and hemlock, has been found by *Dr Morries* to yield by destructive distillation an empyreumatic oil of great activity. Its poisonous properties, however, are not essential to the oil, but reside in a volatile principle which may be detached by weak acetic acid. Dr Morrie has not ascertained what relation this principle bears to the hyoscyamia of Brandes; but it is an active poison, small doses producing in rabbits, convulsions, coma, and speedy death [*].

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* Schweigger's Journal der Chemie, xviii. 91.

† Annalen der Pharmacie, i. 333.

‡ Ibidem, 1833, or Journal de Pharmacie, xx. 92.

Runge proposes as evidence of poisoning with hyoscyamus, i common, however, with stramonium and belladonna, to concentrate a solution of the contents of the stomach, and apply it t a cat's eye to dilate the pupil. Dilatation was even produce by an extract obtained from the urine of a rabbit which had bee fed some time on hyoscyamus [†].

According to the experiments of *Professor Orfila*, the juic or extract procured from the leaves, stems, and especially th root, produces in animals a state of sopor much purer than that caused by opium. It is most active when injected into the jugular vein, less so when applied to the cellular tissue, and still less when introduced into the stomach. Except occasional paralysis of the heart, indicated by florid blood in its left cavities, no morbid appearance is to be found in the dead body. Six drachms of the pharmaceutic extract of the leaves killed a dog in two hours and a quarter when swallowed; and three drachms killed another in four hours through a wound in the back. Its action appears to be exerted through the medium of the blood-vessels, and is purely narcotic [‡].

Orfila has farther made some interesting remarks as to the effect of season and vegetation on its energy as a poison. The root is the most active part of the plant; but in the spring it is almost inert. Thus the juice of three pounds of the root collected near the end of April, when the plant has hardly begun to shoot, killed a dog in somewhat less than two days; while a decoction of an ounce and a-half collected on the last day of June, when the plant was in full vegetation, proved fatal in two hours and a-half. The extract prepared from the leaves, and procured from different shops, he found to vary greatly in point of strength, some samples being absolutely inert [‡]. The causes of these differences have been ascertained experimentally by

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[*] Edinburgh Medical and Surg. Journal, xxxix. 381.

[†] *Orfila*, Médecine-Légale, iii. 374.

[‡] *Orfila*, Toxicologie Générale, ii. 137.

Brandes to be, that the herb loses its active principle in part by decomposition in the process of simple desiccation, and also when long kept; and that the greater part is also similarly decomposed in the process for preparing an extract, unless the process be quickly finished, and yet at a low heat.

The seeds of hyoscyamus are poisonous, as well as the leaves and root. Indeed the whole plant is so. The seeds contain much more hyoscyamia than the leaves.

The oleaginous hyoscyamia of Brandes in the dose of a few drops kills small animals in two or three minutes. The only marked symptoms are agitation, prostration, and before death convulsions; and in the dead body the venous system, especially of the head, is found much gorged. The pure crystalline principle of Brandes and Geiger's is also highly energetic.

The effects of Hyoscyamus on man differ somewhat from those on animals, and vary greatly with the dose.

In medicinal doses it commonly induces pleasant sleep. This indeed has been denied by *M. Fouquier*, who infers from his experiments that it never causes sleep, but always headach, delirium, nausea, vomiting, and feverishness*. I have certainly seen it sometimes have these effects; but much more generally it has acted as a pleasant anodyne.

Its effects in large doses have been well described by *M. Choquet* as they occurred in two soldiers who ate the young shoots dressed with olive-oil. They presently became giddy and stupid, lost their speech, and had a dull, haggard look. The pupils were excessively dilated, and the eyes so insensible that the eyelids did not wink when the cornea was touched,—the pulse was small and intermitting, the breathing difficult, the jaw locked, and the mouth distorted by *risus sardonicus*. Sensibility was extinct, the limbs were cold and palsied, the arms convulsed, and there was that singular union of delirium and coma which is usually termed typhomania. One of the men soon vomited freely under the influence of emetics, and in a short time got quite well. The other vomited little. As the palsy and somnolency abated, the delirium became extravagant, and the patient quite unmanageable till the evening of the subsequent day, when the operation of brisk purgatives restored him to his senses. In two days both were fit for duty †.

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* Archives Gén. de Méd. i. 297. † *Corvisart's* Journal de Méd. xxvi. 353.

In a treatise on vegetable poisons, *Mr Wilmer* has related the history of six persons in a family, who were poisoned by eating at dinner the roots of the hyoscyamus by mistake instead of parsneps. Several were delirious and danced about the room like maniacs, one appeared as if he had got drunk, and a woman became profoundly and irrecoverably comatose. Emetics could not be introduced into the stomach, stimulant clysters had no effect, external stimuli of every kind failed to rouse her, and she expired next morning at six [*]. The roots in this instance were gathered in the winter time,—a fact which does not quite coincide with the conclusions to be drawn from Orfila's experiments, that the plant must be in full vegetation before its energy as a poison is considerable.

From these and other cases, the abstracts of which are to be seen in Orfila's Toxicology, or in Wibmer's treatise on the operation of medicines and poisons, it follows that hyoscyamus in a poisonous dose causes loss of speech, dilatation of the pupil, coma, and delirium, generally of the unmanageable, sometimes of the furious kind. It has been known to act powerfully in the form of a clyster [†]. It has also been known to act with considerable energy even through the sound skin, as appears from a case which occurred to *Wibmer*. He was called to a lady affected with great stupor, dilated pupils, flushed face, loss of speech, full hard pulse, and swelling of the abdomen; and he found that these symptoms were owing to several ounces of henbane leaves having been applied to the belly in a poultice, on account of strangury and tympanitis. She was still capable of being roused by speaking loudly close to her ear; and under proper treatment she recovered [‡].

Henbane seldom causes any distinct symptoms of irritant poisoning. In several however of the cases related by the older modern authors some pain in the belly, a little vomiting, and more rarely diarrhœa, appear to have occurred [§]. *Plenck*, however, quotes, from a Swedish authority, an instance of its having produced burning in the stomach, intense thirst, watching, delirium, depraved vision, and next day a crowded eruption of dark spots and vesicles, which disappeared on the supervention of a profuse diarrhœa [*]. The same author alludes to cases where it proved fatal; but this event is rare, obviously because the precursory stage of delirium gives an opportunity of removing the poison, before the stage of coma is formed. A fatal case has been related in Pyl's Magazin. Two boys a few minutes after eating the seeds were attacked with convulsions and heat in the throat; and one of them, who could not be made to vomit, died in the course of the ensuing night [†].

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[*] On the Poisonous Vegetables of Great Britain, p. 3.

[†] *Foderé*, Médecine-Légale, iv. 25.

[‡] Die Wirkung der Arzneimittel und Gifte, iii. 154.

[§] Acta Curiosorum Naturæ. Also *Wibmer*, Die Wirkung, &c. 146–154.

The accidents it has occasioned have commonly arisen from the individuals confounding the root with that of the wild chicory or with the parsnep, to the latter of which it bears a considerable resemblance.

Of the other species of the Hyoscyamus, the *H. albus* has been known to cause symptoms precisely the same with those above described. *Professor Foderé* has given a good example of its effects on man, as they occurred in the crew of a French corvette in the Archipelago. The plant was boiled and distributed among the whole ship's company, as several of the sailors said they knew it to be eatable and salubrious. But in no long time they were all seized with giddiness, vomiting, convulsions, colic, purging, and delirium of the active kind. They were all soon relieved by emetics and purgatives [‡].

Dr Archibald Hamilton has described a case of the same nature, which was caused by the seeds of this plant. A young medical student, who took about twenty-five grains of the seeds, was seized in half an hour with lassitude and somnolency, and successively with dryness of the throat, impeding deglutition, convulsive movements of the arms, incoherency, total insensibility of the skin, and loss of recollection. These symptoms continued about twelve hours, and then slowly receded [§].

Three other species, the *H. aureus*, *physaloides*, and *scopolia* are represented by Orfila to be equally deleterious.

Of Poisoning with Lactuca.—Allied in its effects, but greatly inferior in power to opium and hyoscyamus, is the *Lactuca vi-*

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[*] Toxicologia, p. 87.

[†] Neues Magazin, ii. 3, p. 100.

[‡] Foderé, Médecine-Légale, iv. 23. For another instance of the effects of the seeds, not however fatal, see Acta Helvetica, v. 333.

[§] Edin. Phys. and Lit. Essays, ii. 268.

rosa, together with the *Lettuce-Opium*, or extract of the *L. sativa.*

Orfila found that three drachms of the extract of *L. virosa* introduced into the stomach of a dog killed it in two days, without causing any remarkable symptom; that two drachms applied to a wound in the back induced giddiness, slight sopor, and death in three days; and that thirty-six grains injected in a state of solution into the jugular vein caused dulness, weakness, slight convulsions, and death in eighteen minutes [*]. This poison, therefore, like other narcotics, acts through absorption. But it is far from being energetic; and it farther appears probable that the extract is very uncertain in strength,—as may indeed be inferred from the variable nature of the processes by which it is prepared.

Of Poisoning with Solanum.—Different species of the *Solanum*, a genus of the same natural order with the Hyoscyamus, have been considered by Orfila to possess the same properties, though in a much feebler degree. The *S. dulcamara* or Bittersweet has been erroneously believed by some to possess distinct narcotic properties [†]. *M. Dunal* found that a dog might take 180 of the berries or four ounces of the extract without any inconvenience, and quotes an experiment on the human subject where thirty-two drachms of extract were taken in two doses also without injury [‡]. If it has any power at all, therefore, it must possess too little to be entitled to the name of a poison.—*Chevallier* says he knew an instance of a druggist's apprentice being attacked with deep somnolency for ten hours after carrying a large bundle of it on his head [§]; but some other cause may be justly suspected to have here been in operation.—The *S. nigrum* or Common Nightshade has been made the subject of experiment by Orfila, who found its extract to possess nearly the power and energy of lettuce-opium [‖].—The *S. fuscatum* is rather more active, fifteen berries having caused hurried breathing and vomiting [¶]. The *S. mammosum* is also probably an active species, the capsule of the berries having been known to excite vomiting, giddiness, and confusion of mind [*]. In the *S. nigrum* and *dulcamara*, *M. Desfosses* discovered in 1821 a peculiar alkaloid, which induces somnolency in animals, but is not a very active poison [†].

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[*] Toxicol. Gén. ii. 184.

[†] *Dr Schlegel*, in Hufeland's Journal, liv. ii. 29.

[‡] Histoire des Solanum. 1813.

[§] Annales d'Hyg. Publique et de Méd. Légale, viii. 334.

[‖] Toxicol. Gén. ii. 190.

[¶] Dunal, &c.

Violent effects have often been assigned to this genus, in consequence of its similarity to a powerful poison, the *Atropa Belladonna;* which indeed has been described by the older authors under the name of *Solanum furiosum*. It will be noticed among the Narcotico-Acrid Poisons.

An alkaloid has been indicated by several chemists in various species of Solanum. The most recent account, that of *Otto*, represents it to be a pearly, white, pulverulent substance, alkaline in reaction, and capable of uniting with acids. One grain of sulphate of solania killed a rabbit in six hours, and three grains a stronger rabbit in nine hours,—the symptoms being those of narcotic poisoning [‡].

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[*] *M. Des-Alleurs* in Journ. de Chim. Méd. ii. 30.

[†] Bulletins de la Soc. Méd. d'Emul.—*Mars* 1821.

[‡] Journal de Pharmacie, xx. 96.

CHAPTER XXIX.

OF POISONING WITH HYDROCYANIC ACID.

The poisons whose energy depends on the presence of the Prussic or Hydrocyanic Acid are of great interest to the physiologist as well as the medical jurist. Some of them are natural productions, derived from the leaves, bark and fruit-kernels of certain plants; others are formed artificially by complex chemical processes. The species to be here noticed are the *Hydrocyanic Acid* itself, and the Essential Oils and Distilled Waters of the *Bitter Almond*, the *Cherry-Laurel*, the *Peach-Blossom*, the *Cluster-Cherry*, and the *Mountain-Ash*. These poisons have for some time attracted great attention on account of their extraordinary power. And indeed in rapidity of action or in the minuteness of the quantity in which they operate, no poison surpasses and very few equal them. They are exceedingly interesting to the medical jurist, because, as they are now generally known, their effects often become the subject of medico-legal investigation. They have been repeatedly taken by accident, and they have often been resorted to for committing suicide. They have likewise been employed as the instruments of murder. A remarkable instance occurred in England towards the close of last century, where murder was committed with the cherry-laurel water; and a case was also tried a few years ago in England where death was occasioned by hydrocyanic acid, and the prisoner was charged with administering it, but was found not guilty. These cases will be noticed presently.

Of the Hydrocyanic Acid.

Section I.—*Of its Chemical History and Tests.*

This singular substance was discovered some time ago by Scheele; but Gay-Lussac was the first who obtained it in a state of purity. It is familiarly known to chemists under two forms,—as a pure acid, and diluted with water.

The pure acid is liquid, limpid, and colourless. It has an acrid, pungent taste, and a very peculiar odour, which, when diffused through the air, has a distant resemblance to that of bitter almonds, but is accompanied with a peculiar impression of acridity on the nostrils and back of the throat. It is an error, however, to suppose, as is very generally done, that the odour is the same with that of the almond. It boils at 80°; freezes at 5°; and is very inflammable. I have kept it unchanged for a fortnight in ice-cold water; but at ordinary temperatures it decomposes spontaneously, and becomes brown, sometimes in an hour, and commonly within twelve hours. On this account it is extremely improbable that a case will ever happen, in which the medical jurist will have to examine it in its concentrated form.

When united with water it forms the acid discovered by Scheele, and now kept in the apothecary's shop. In this state it has the same appearance, taste, and smell as the pure acid; but it is less volatile, does not burn, and may be preserved long without change, if excluded from the light. In consequence of its volatility, however, it becomes weak, unless kept with great care; many samples of it also undergo decomposition, and deposit brown flakes, if not excluded from the light; and hence the acid of the shops is very variable in point of strength. But it is singular that, as *Giese* and *Pfaff* have stated, and as I have myself invariably remarked, the acid prepared by decomposing the solution of the ferrocyanate of potass by sulphuric acid may be kept for years, even exposed to diffuse light, without being decomposed at all. A French physician made some experiments not long ago on the uncertainty of the strength of the medicinal acid; and he found that he could swallow a whole ounce of one sample, and a drachm of a stronger sample, without sustaining any injury; but on trying some which had been recently prepared by Vauquelin, he was immediately taken ill, as will be related presently, and narrowly escaped with his life [*]. —The acid of commerce differs much in strength, according to the process by which it has been prepared, and independently of decomposition by keeping. The medicinal acid of this country is intended to be an imitation of that of *Vauquelin*, which contains 3.3 per cent. [†] That of *Giese*, which keeps remarkably well, is of the same strength; that of *Schrader* contains only one per cent.; that of *Göbel* 2.5 per cent.; that of *Ittner* 10 per cent.*; that of *Robiquet* 50 per cent.† Of the alcoholic solutions the best known are that of *Schrader*, which contains about 1.5 per cent. of pure acid,—that of the *Bavarian Pharmacopœia*, which contains 4 per cent.,—that of *Duflos*, 9 per cent.,—that of *Pfaff* 10 per cent.,—and that of *Keller*, 25 per cent.* These statements are necessary for understanding the cases of poisoning published in foreign works.

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[*] Revue Médicale, xvii. 265.

[†] *Schubarth* in Journal der Praktischen Heilkunde, li. i. 125.

The tests for the Hydrocyanic acid have been lately examined by *M. Lassaigne* of Paris, by *Dr Turner* of London, and by *Professor Orfila*. They are its odour, the salts of copper, the salts of the protoxide of iron, and nitrate of silver.

The *peculiar odour* of the acid is a very characteristic and delicate test of its presence. According to *Orfila*, the smell is perceptible when no chemical reagent is delicate enough to detect it‡. But I doubt the accuracy of this statement, and may farther observe, that I have known some persons who are nearly insensible of any smell, even in a specimen which was tolerably strong. Hence when the odour is resorted to as a test it ought to be tried by several persons.

The *Sulphate of Copper* forms with hydrocyanic acid, when rendered alkaline with a little potass, a greenish precipitate, which becomes nearly white, on the addition of a little hydrochloric acid. The purpose of the hydrochloric acid is to redissolve some oxide of copper thrown down by the potass. The precipitate is then the cyanide of copper. This test, according to Lassaigne, will act on the poison when dissolved in 20,000 parts of water. But as the precipitate is not coloured, the test is an insignificant one compared with the next.

If the acid is rendered alkaline by potass, the *Salts of the Protoxide of Iron* produce a grayish-green precipitate, which, on the addition of a little sulphuric acid, becomes of a deep Prussian blue colour. The common green vitriol answers very well for this purpose. The salts of the peroxide of iron will also often answer, because, unless carefully prepared, they are never altogether free of protoxide. But, contrary to what is stated by *Lassaigne*,—by *MM. Thenard*, *Vauquelin*, and *Ma-*

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[*] *Fechner's* Repertorium der Organischen Chemie, ii. 70, 75.

[†] Codex Medicamentarius, 389.

[‡] Archives Générales de Médecine, xx. 386.

gendie[*], the Reporters of the Academy on his paper,—and more recently by *Orfila*[†], the salts of the pure peroxide of iron have no such effect. They cause with the potass a brownish precipitate, which is redissolved on the addition of sulphuric acid, leaving the solution limpid. These errors have been rectified by *Dr Turner*, who also shows, contrary to the statements of Lassaigne, that the protosulphate of iron is a more delicate test than the sulphate of copper[‡]. This I have also had occasion to remark.

The *Nitrate of Silver* is considered by Professor Orfila a very delicate and characteristic reagent for hydrocyanic acid. A white precipitate, the cyanide of silver, is produced in a very diluted solution; and this precipitate is distinguished from the other white salts of silver, by being insoluble in nitric acid at ordinary temperatures, but soluble in that acid at its boiling temperature. In this action it is necessary to observe that something more is accomplished than simple solution; the cyanide is decomposed, nitrate of silver is formed, and hydrocyanic acid is disengaged by the ebullition. A more characteristic property is, that the precipitate when dried and heated emits cyanogen gas, which is easily known by the beautiful rose-red colour of its flame[§].

Sometimes it is necessary to determine the strength of diluted hydrocyanic acid; because, on account of its tendency to decomposition, doubts may be entertained whether a mixture which contains it is strong enough to be dangerously poisonous. According to Orfila, the best method of ascertaining the strength either of a pure solution or of a mixture in syrup, is to throw down the acid with the nitrate of silver and dry the precipitate; a hundred parts of which correspond to 20.33 of pure hydrocyanic acid.

Process for Mixed Fluids.—Some important observations have been lately made by *MM. Leuret* and *Lassaigne* on the effect of mixing animal matters with hydrocyanic acid. The most material of their results are, that if the body of an animal poisoned with the acid is left unburied for three days, the poiso can no longer be detected; and that if it is buried within twent four hours the poison may be found after a longer interval, bu never after eight days. The reason is either that the acid volatilizes, or that it is decomposed. The possibility thus indicated of detecting the poison in the body some days afte death has been since confirmed by actual examination in a medico-legal case. In a case of poisoning with hydrocyanic acid, followed by dismemberment of the body for the purpose of concealment, distinct proof of the presence of the poison seven days after death was obtained by the second of the succeeding processes, although the trunk of the body had never been buried, but had been for some time lying in a drain *.

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[*] Ann. de Chim. et de Phys. xxvii. 200.

[†] Archives Générales de Méd. xx. 387.

[‡] Edin. Med. and Surg. Journal, xxx. 344.

[§] Archives Générales de Méd. xx. 386.

For detecting the poison in mixed fluids *Orfila* has lately advised the following process. The fluid may be treated with animal charcoal without heat. The colour being thus generally destroyed, the tests will sometimes act as usual. Or, without this preparation, a slip of bibulous paper moistened with pure potass, may be immersed in the suspected fluid for a few minutes, and then touched with a solution of sulphate of iron: upon which the usual blue colour will be produced on the paper. If neither of these methods should answer, the fluid is to be distilled †.

Distillation of the fluid is on the whole the best mode of procedure. It was proposed some time before by *Lassaigne* and *Leuret* for detecting the poison in the stomach after death. The steps of their process, which appears to me the best yet proposed, are as follows. The contents after filtration are to be neutralized with sulphuric acid if they are alkaline, in order to fix the ammonia which may have been disengaged by putrefaction; the product is then to be distilled from a vapour-bath till an eighth part has passed over into the receiver; and the distilled fluid is to be tested with the protosulphate of iron in the usual way ‡. *Orfila* maintains that from hydrocyanized syrup only two-thirds of the acid can be distilled over; and cautions the analyst against estimating quantity by such means §.

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* *Chevallier*, Annales d'Hygiène Publique, &c. ix. 337.

† Archives Gén. de Méd. xx. 387.

‡ Journ. de Chim. Méd. ii. 561.

§ Médecine-Légale, iii. 385.

By this process *Lassaigne* could detect the poison in a cat or dog killed by twelve drops and examined twenty-four or forty-eight hours after death [*]. But *Dr Schubarth* has objected to it,—and the same objection will apply to every process in which heat is used,—that hydrocyanic acid may be formed during the distillation by the decomposition of animal matter [†]. His objection, however, appears only to rest on conjecture or presumption at farthest; and I doubt whether, supposing the distillation to go on slowly in the vapour-bath, the heat is sufficient to bring about the requisite decomposition. The force of the objection must be decided by future researches.

It is worthy of remark that hydrocyanic acid is apt to be formed in the course of the changes produced by various agents in organic matters. These are probably more numerous than the toxicologist is at present exactly aware of. An instance of its formation in the course of the decay of unsound cheese has been ascertained lately by *Dr Witling* [‡]; and another example will be mentioned under the head of Spurred Rye.

SECTION II.—*Of the Action of Hydrocyanic Acid and the Symptoms it excites in Man.*

The effects of hydrocyanic acid on the animal system have been examined by several physiologists. The best experiments with the concentrated acid are those of *M. Magendie*; who says that, if a single drop be put into the throat of a dog, the animal makes two or three deep hurried respirations, and instantly drops down dead; that it causes death almost as instantaneously when dropped under the eyelid; and that when it is injected into the jugular vein the animal drops down dead at the very instant, as if struck with a cannon-ball or with lightning [§].

On repeating these experiments in order to determine less figuratively the shortest period which elapses before the poison begins to operate, as well as the shortest time in which it proves fatal,—two points it will presently be found important to know,—I found that a single drop weighing scarcely a third of a grain dropped into the mouth of a rabbit killed it in eighty-three seconds, and began to act in sixty-three seconds,—that three drops weighing four-fifths of a grain, in like manner killed a strong cat in thirty seconds, and began to act in ten,—that another was affected by the same dose in five and died in forty seconds,—that four drops weighing a grain and a fifth did not affect a rabbit for twenty seconds, but killed it in ten seconds more,—and that twenty-five grains, corresponding with an ounce and a half of medicinal acid, began to act on a rabbit as soon as it was poured into its mouth, and killed it outright in ten seconds at farthest. Three drops projected into the eye acted on a cat in twenty seconds, and killed it in twenty more; and the same quantity dropped on a fresh wound in the loins acted in forty-five and proved fatal in 105 seconds. In the slower cases now enumerated there were regular fits of violent tetanus; but in the very rapid cases the animals perished just as the fit began to show itself with retraction of the head. In rabbits opisthotonos, in cats emprosthotonos, was the chief tetanic symptom.—The practical application of these experiments will appear presently.

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[*] Ann. de Chim. et de Phys. xxvii. 200.

[†] Hufeland's Journal der Praktischen Heilkunde, lii. i. 92.

[‡] Journal de Chim. Méd. vi. 723.

[§] Ann. de Chim. et de Phys. vi. 347.

Of all the forms in which the acid can be administered, that of vapour appears the most instantaneous in operation. *M. Robert* found, that when a bird, a rabbit, a cat, and two dogs were made to breathe air saturated with its vapour, the first died in one second, the second also in a single second, the cat in two, one dog in five, and the other dog in ten seconds [*].

The effects of the diluted acid are the same when the dose is very large, but somewhat different when inferior doses are given. These effects have been observed by many physiologists; but the most accurate and extensive experiments are those of *Emmert* published in 1805 [†], those of *Coullon* in 1819 [‡], and those of *Krimer* in 1827 [§]. They found that when an animal is poisoned with a dose not quite sufficient to cause death, it is seized in one or two minutes with giddiness, weakness, and salivation, then with tetanic convulsions, and at last with gradually increasing insensibility; that after lying in this state for some time, the insensibility goes off rapidly, and is succeeded by a few attacks of convulsions and transient giddiness; and that the whole duration of such cases of poisoning sometimes does not exceed half an hour, but may extend to a whole day or more. —When the dose is somewhat larger the animal perishes either in tetanic convulsions or comatose; and death for the most part takes place between the second and fifteenth minute. I have seen the diluted acid, however, prove fatal with a rapidity scarcely surpassed by the pure poison. Thus in an experiment with Vauquelin's acid made on a strong cat at the same time with the second and third of the experiments with the pure acid detailed above, I found that thirty-two grains, which contain one of real acid, began to act in fifteen seconds, and proved fatal in twenty-five more. According to *Schubarth's* experiments death may be sometimes delayed for thirty-two minutes [*]; but if the animal survives that interval, it recovers. He farther states, that during the course of the symptoms the breath exhales an odour of hydrocyanic acid [†]. *Coullon* once saw a dog die after nineteen hours of suffering; but cases of this duration are exceedingly rare [‡].—When the dose is very large, *Mr Macaulay*, as will afterwards be mentioned, (p. 705,) has found death take place in a few seconds, exactly as when the pure acid is given.

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[*] Annales de Chimie, xcii. 59.

[†] Diss. Inaug. de Venenatis Acidi Borussici in Animalia effectibus. Tubingæ, 1805.

[‡] Recherches et Considérations sur l'Acide Hydrocyanique. Paris, 1819.

[§] Journal Complément. xxviii. 33.

The body presents few morbid appearances of note. The brain is generally natural. Yet occasionally its vessels are turgid; and Schubarth once found even an extravasation of blood between its external membranes in the horse [§]. The heart and great vessels are distended with black blood, which is commonly fluid, but occasionally coagulated as usual. The lungs according to Schubarth, are sometimes pale, but much more generally injected and gorged with blood [‖]. The pure acid, according to Magendie, exhausts the irritability of the heart and voluntary muscles so completely, that they are insensible even to the stimulus of galvanism [¶]. The diluted acid has not always this effect. In the experiments of Coullon the heart and intestines contracted, and the voluntary muscles continued contractile, after death as usual [*]. But Schubarth states that the heart is never contractile, although the intestines and voluntary muscles retain their contractility [†]. The reason of these discrepant statements is that, as I have had occasion to observe, a considerable difference really prevails in experiments conducted under circumstances apparently the same. In eight experiments on cats and rabbits with the pure acid the heart contracted spontaneously, as well as under stimuli, for some time after death, except in the instance of the rabbit killed with twenty-five grains, and one of the cats killed by three drops applied to the tongue. In the last two the pulsation of the heart ceased with the short fit of tetanus which preceded death; and in the rabbit, whose chest was laid open instantly after death, the heart was gorged and its irritability utterly extinct.

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[*] Bemerkungen über die Wirkungen der Blausaüre. Hufeland's Journal der Praktischen Heilkunde, lii. i. 88.

[†] Bemerkungen, &c. 85.

[‡] Recherches, &c. p. 136. [§] Bemerkungen, &c. 81. [‖] Ibid. 82.

[¶] Ann. de Chim. et de Phys. vi.

The experiments of Emmert, Coullon, and Krimer show that the diluted acid acts most energetically through the serous membranes, and next upon the stomach; that it also acts with energy on the cellular tissue; that it has no effect when applied to the trunks or cut extremities of nerves, or to a fissure made in the brain or spinal marrow; that its action is prevented when the vessels of any part are tied before the part is touched with the poison; that its action is not prevented by previously dividing the nerves; and that it may sometimes be discovered in the blood after death by chemical analysis [‡], and frequently by the smell when analysis cannot succeed in separating it [§]. These results favour the supposition that hydrocyanic acid acts through the medium of the blood-vessels. But the extreme rapidity of its operation in large doses is usually considered incompatible with an action through the blood, or any other channel except direct conveyance along the nerves. The tremendous rapidity of action indicated by the experiments of *Magendie*, of *Mr Macaulay*, (p. 705,) of *M. Robert*, as well as in some of those performed by myself,—certainly appears rather inconsistent with the notion, that the acid must enter the blood-vessels before producing its effects.

Hydrocyanic acid probably acts even through the sound skin.

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[*] Recherches, &c. 146.

[†] Bemerkungen, &c. 83.

[‡] *Krimer* detected the acid in the blood of the heart of an animal killed in 36 seconds by a few drops put on the tongue. Journ. Complémentaire, xxviii. 37.

[§] *Lassaigne*, Journ. de Chim. Méd. ii.

It has not hitherto, indeed, been found to affect animals in this way, evidently because their skin is too thick and impermeable. But *M. Robiquet* informed me that once, while he was making some experiments on the tension of its vapour, his fingers, after being some time exposed to it, became affected with numbness, which lasted several days; and *Emmert* also found that the essential oil of bitter almond applied to the uninjured skin of the back of a rabbit produced the usual symptoms and death: and that the peculiar odour of the poison was quite distinct after death in the deep-seated muscles of the back [*].

This acid acts on the brain and also on the spine independently of its action on the brain. Its action on both is clearly indicated by the combination of coma with tetanus. The independent action on the spine is well shown by the following experiment of *Wedemeyer*. In a dog the spinal chord was divided at the top of the loins, so that no movement took place when the hind-legs were pricked: Hydrocyanic acid being then introduced into a wound in the left hind-leg, symptoms of poisoning commenced in one minute, and the hind-legs were affected with convulsions as well as the fore-legs [†].

Hydrocyanic acid affects all animals indiscriminately. From the highest to the lowest in the scale of creation, all are killed by it; and all perish nearly in the same manner. Such is the result of a very extensive series of experiments by *Coullon*.

This substance is poisonous in all its chemical combinations. *Coullon* remarked that two drops of the hydrocyanate of ammonia killed a sparrow in two minutes [‡]; *Robiquet* and *Magendie* found that a hundredth part of a grain of the hydrocyanate of potass killed a linnet in thirty seconds, and five grains a large pointer in fifteen minutes [§]; *Orfila* has related an instance of death in the human subject within an hour after the administration of six grains of hydrocyanate of potassa in an injection [||]; and *Schubarth* killed a dog in twenty minutes with twenty drops of the diluted acid neutralized by ammonia[*], and another in three hours with twenty-five drops neutralized by potass. These facts are a sufficient answer to a statement made by *Mr Murray* of London, to the effect, that a considerable dose of the acid may be given without injury to a rabbit, if previously rendered alkaline by ammonia[†]. But, nevertheless, as will be seen under the head of the treatment, ammonia, as Mr Murray stated, is a good antidote when administered after the poison as a stimulant.

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[*] Ueber das Amerikanische Pfeilgift. *Meckel's* Archiv für Anat. und Physiol. iv. 203.

[†] Versuche ueber das Nervensystem, 271, quoted by *Marx*, die Lehre von den giften, I. ii. 154.

[‡] Recherches, &c. 221.

[§] Journal de Physiol. iii. 230.

[||] Annales d'Hyg. Publique et de Méd. Légale, xi. 240.

The triple prussiates, or, as they are now termed, the *ferrocyanates*, do not possess deleterious properties. These salts were at one time considered compounds of hydrocyanic acid with a double oxidized base, oxide of iron being one. Thus the common prussiate of potass was considered a compound of hydrocyanic acid with potass and oxide of iron. *Mr Porrett*, however, suggested,—and his views are now generally adopted by chemists,—that the acid is not the hydrocyanic, and the iron not in the state of oxide; but that there is only one base in union with a hydracid consisting of hydrogen, azote, carbon and metallic iron, and denominated the Ferrocyanic acid. The physiological effects of this substance, which have been examined by many experimentalists, are strongly favourable to Porrett's opinion; for although some have found it poisonous, all agree in assigning it very feeble properties, and some have not been able to discover in it any deleterious quality at all. Coullon observes that *Gazan* killed a dog with two drachms, and *Callies* another with three drachms of the salt met with in commerce.[‡] *Schubarth* found that half an ounce had not any material effect on dogs, even when vomiting did not occur for half an hour[§]; and *Callies*, who found the salt of commerce somewhat poisonous, also remarked, that when it was carefully prepared several ounces might be given without harm[||]. *D'Arcet* once swallowed half a pound of a solution without any injury[¶]. Similar results were obtained previously with smaller doses by *Wollaston*, *Marcet*, [*], and *Emmert* [†], as well as afterwards by *Dr Macneven* [‡], and *Schubarth* [§], who found that a drachm or even two drachms might be taken with impunity by man and the lower animals.

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[*] *Horn's* Archiv, 1824, i. 75.

[†] Edin. Journal of Science, ii. 215.

[‡] Recherches, &c. 221.

[§] *Horn's* Archiv für Medizinische Erfahrung, 1827, i. 73.

[||] *Coullon*, 221.

[¶] Revue Médicale, xvii. 271.

The *Sulpho-cyanic acid*, another substance analogous in chemical nature to the ferrocyanic, was once supposed like it to be a poison of great activity, but this is doubtful. *Professor Mayer* of Bonn found that a drachm and a-half of a moderately strong solution of the acid sometimes killed a rabbit in ninety seconds when injected into the windpipe, and that the same quantity of a solution of sulpho-cyanate of potassa might occasion death in the course of four hours; but that some rabbits took half an ounce of the former and three drachms of the latter without material harm, both when administered through the windpipe, when injected into the rectum, and when introduced into the stomach by a gullet-tube. In the fatal cases death took place under symptoms of oppressed breathing, rarely attended with convulsions; and extensive traces of irritation were found in the alimentary canal [||]. *Dr Westrumb* of Hammeln, however, seems to have found it more active in the form of sulpho-cyanate of potassa. Two scruples in an ounce of water produced in a dog spasmodic breathing, convulsions, efforts to vomit, and death in seven minutes; and forty grains killed another in less than two hours. In the latter animal he detected the poison by the persulphate of iron in the blood, lungs, liver, spleen, and kidneys [¶]. Some experiments by *Soemering* would even prove it to be a poison of very great energy; for half a drachm of concentrated sulpho-cyanic acid given to a dog occasioned immediate death; and the same quantity of sulpho-cyanate of potassa killed another in one minute [**].

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[*] *Nicholson's* Journal, xxxi. 191.

[†] Uber die giftige Wirkungen der unächten Angustura.—Hufeland's Journal xl. iii. 68.

[‡] Archives Gén. de Méd. iii. 269.

[§] *Hufeland's* Journal, lii. i. 93.

[||] *Wibmer*. Die Wirkung der Arzneimittel und Gifte, iii. 138, from *Harless*, Jahrbuch der Medizin, ix. 1. This account of Mayer's experiments differs materially from what was given in the last edition of this work from the French Bulletin des Sciences Médicales, vi. 257; nor is the present the only occasion where I have observed that the analyses of German works in that periodical are not always to be depended on.

[¶] *Meckel's* Archiv für Anat. und Physiol. vii. 543, 545.

[**] *Wibmer*. Die Wirkung der Arzneimittel, &c. iii. 136.

Cyanic and *Cyanous acids* are not poisonous according to the experiments of Hünefeld *; but *Cyanogen* is a powerful poison, as will be mentioned under the head of the Narcotic Gases.

The symptoms of hydrocyanic acid observed in man are very similar to those witnessed in animals.

Coullon has given a good account of the effects of small doses as ascertained by experiment on himself. When he took from 20 to 86 drops of the diluted acid, he was attacked for a few minutes with nausea, salivation, hurried pulse, weight and pain in the head, succeeded by a feeling of anxiety, which lasted about six hours †. Such symptoms are apt to be induced by too large medicinal doses. Another remarkable symptom which has been sometimes remarked during its medicinal use is salivation, with ulceration of the mouth. *Dr Macleod* thrice had occasion to remark this in patients who had been using the drug for about a fortnight, and twice in one individual; and *Dr Granville* says he had also twice witnessed the same effect ‡.

As to the effects of fatal doses, it is probable that in man, as in animals, two varieties exist. When the dose is very large, it is reasonable to suppose that death will take place suddenly, without convulsions. But for obvious reasons the symptoms in such cases have not been hitherto witnessed.

The most complete account of the symptoms from fatal doses when convulsions occur, is given in a case reported by *Hufeland* of a man, who, when apprehended for theft, swallowed an ounce of alcoholized acid, containing about forty grains of the pure acid. He was observed immediately to stagger a few steps, and then to sink down without a groan, apparently lifeless. A physician, who instantly saw him, found the pulse gone and the breathing for some time imperceptible. After a short interval he made so forcible an expiration that the ribs seemed drawn almost to the spine. The legs and arms then became cold, the eyes prominent, glistening, and quite insensible; and after one or two more convulsive expirations he died, five minutes after swallowing the poison §.

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* *Horn's* Archiv für Medizinische Erfahrung, 1830, ii. 858.

† Recherches, &c. 127.

‡ London Med. and Phys. Journal, xlvi. 359 and 363.

§ Journal der Praktischen Heilkunde, xl. i.85.

In Horn's Journal is recorded another case which also proved fatal in five minutes, with precisely the same symptoms [*]. A short notice of what appears to have been a similar case is given in the Annales de Chimie. The person was a chemist's servant, who swallowed a large quantity of the alcoholic solution, by mistake for a liqueur, the poison having been accidentally left on the table by her master, who had been showing it as a curiosity to some friends. No account is given of the symptoms, farther than that she died apoplectic in two minutes[†]. To these cases may be also added a short notice of the French physician's case mentioned at the commencement of this chapter. It will convey a good idea of the operation of the poison when not quite sufficient to kill. Very soon after swallowing a teaspoonful of the diluted acid he felt confusion in the head, and soon fell down insensible, with difficult breathing, small pulse, bloated countenance, dilated insensible pupils, and locked jaw. Afterwards he had several fits of tetanus, one of them extremely violent. In two hours and a-half he began to recover his intellects and rapidly became sensible; but for some days he suffered much from ulceration of the mouth and violent pulmonary catarrh, which had evidently been excited by the ammonia given for the purpose of rousing him. This gentleman had eructations with the odour of the acid three or four hours after he took it; and during the earlier symptoms the same odour was exhaled by his breath [‡].

Hydrocyanic acid is not considered a cumulative poison,—that is, the continued use of frequent small doses is not believed to possess the power recognized in iodine, mercury, and foxglove, of gradually and silently accumulating in the body and then suddenly breaking out with dangerous or fatal violence. The frequent experience of practitioners in this and other countries seems to prove that hydrocyanic acid possesses no such property. It is right at the same time to mention, that a case has been published by *Dr Baumgärtner* of Freyburg which tends rather to establish the reverse. A man had taken for two months, on account of chronic catarrh, ten drops of Ittner's acid daily in doses of one grain, without experiencing the slightest toxicological effect. At length he was found one morning in bed apparently labouring under the poisonous operation of the acid. He had headach, blindness, dilated insensible pupil, feeble irregular pulse, occasional suspension of the breathing and rapidly increasing insensibility. The cold affusion and ammonia were immediately resorted to, and at first with advantage. But in no long time spasms commenced in the toes, and gradually affected the rest of the body, till at length violent fits of general tetanus were formed, lasting for six or ten minutes, and alternating in the intervals with coma. Venesection was next resorted to; after which the spasms were confined to the jaw and eyes. Delirium succeeded, but was removed by a repetition of the blood-letting. At four in the afternoon he was tolerably sensible; during the night delirium returned; at ten next morning he recovered his sight; and on the subsequent morning he had no complaint but headach and pain in the eyes *. This case differs so much from every other in the collateral circumstances, as well as in duration, that, although the symptoms themselves correspond exactly with those of poisoning with hydrocyanic acid, we may justly suspect either some other cause, or the accidental administration of too large a dose. It ought, however, to turn the attention of practitioners to the possibility of this poison acting by the accumulation of the effects of small doses frequently repeated for a great length of time.

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[*] Archiv für Mediz. Erfahrung, 1818, 510.

[†] Ann. de Chimie, xcii. 63.

[‡] Revue Médicale, 1825, i. 265.

The period within which Hydrocyanic acid usually proves fatal is fixed with considerable accuracy, not only by the cases observed in the human subject, but likewise by the experiments of many physiologists, and more especially those of *Schubarth*. (p. 696.) It is probable that very large doses occasion death in a few seconds; and at all events a few minutes will suffice to extinguish life when the dose is considerable; but if the individual survive forty minutes, he will generally recover. In the course of a dreadful accident which happened a few years ago in one of the Parisian hospitals, where seven epileptic patients were killed at one time by too large doses of the medicinal acid, it was found that several did not die for forty-five minutes †. But the researches of Schubarth would certainly justify the expectation that recovery will take place under active treatment when the patient survives so long.—These facts may be highly important in the practice of medical jurisprudence.

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* Medizinisch-chirurgische Zeitung, 1829, i. 377.

† Annales d'Hyg. Publ. et de Méd. Lég. ii. 497.

The period within which it begins to operate ought also to be accurately ascertained for the same reason. Indeed a very interesting trial lately took place in this country, where the fate of the prisoner depended in a great measure on the question, within how short a time the effects of this poison must show themselves[*]? The nature of the case was as follows: An apothecary's maid-servant at Leicester, who was pregnant by her master's apprentice, was found one morning dead in bed; and she had obviously been poisoned with hydrocyanic acid. A number of circumstances led to the suspicion that the apprentice was accessary to the administration of the poison. On the other hand, it was distinctly proved that the deceased had made arrangements for a miscarriage by artificial means on the night of her death; and it was therefore represented, on the part of the prisoner, that she had taken the poison of her own accord. But the body was found stretched out in bed in a composed posture, with the arms crossed over the trunk, and the bed-clothes pulled smoothly up to the chin; and at her right side lay a small narrow-necked phial, from which about five drachms of the medicinal prussic acid had been taken, and which was corked and wrapped in paper. There naturally arose a question, whether the deceased, after drinking the poison out of such a vessel, could, before becoming insensible, have time to cork the phial, wrap it up, and adjust the bed-clothes[†]? To settle this point, experiments were made at the request of the Judge, by *Mr Macaulay*, *Mr Paget*, and several other medical men of Leicester; and on the trial they, with the exception of Mr Paget, gave it as their opinion, founded on the experiments, that the supposed acts of volition, although within the bounds of possibility, were in the highest degree improbable. The chief experiments were three in number, from which it appeared that one dog was killed with four drachms in eight seconds, another with four drachms in seven seconds, and another with four drachms and a-half in three seconds; but in other experiments the interval was greater.—For these particulars I am indebted to Mr Macaulay.

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[*] Trial of Freeman for the murder of Judith Buswell at Leicester, April 2, 1829.

[†] *Professor Amos* of the London University, in criticizing in his Lectures what I have said of this case in the first edition of the present work, has accused me of mis-stating the evidence, and grounds the charge on a Report by a professional Reporter, where no notice is taken of the phial having been wrapped up in paper, or of the bed-clothes having been pulled up to the chin, or of the arms being crossed over the trunk. [Lond. Med. Gazette, viii. 577.] I have nevertheless thought it right to retain my original statement of the evidence, as it was derived from what I still consider the best authority,—the medical witness, who mentions the special facts on which he founded the most important, indeed the only important, professional opinion in the case, and to which therefore his attention must have been more pointedly turned than that of any Law-Reporter. The Report alluded to by Professor Amos has been since published in the Medical Gazette, viii. 759.

In the first edition of this work I expressed my concurrence with the majority of the witnesses. But some facts which came subsequently under my notice have led me to think that this concurrence was given rather too unreservedly. I still adhere so far to my original views as to think it improbable that, if the deceased had time after swallowing the poison to cork the phial, wrap it in paper, pull up the bed-clothes and place the bottle at her side, the progress of the symptoms could have been so rapid and the convulsions so slight, as to occasion no disorder in the appearance of the body and the bed-clothes,—and I still likewise think, that after swallowing so large a dose it was improbable she could have performed all the successive acts of volition mentioned above—with ordinary deliberation. But I am informed on good authority, that some gentlemen interested in the case found by actual trial, that all the acts alluded to might be accomplished, if gone about with promptitude, within the short period which in some of their experiments the witnesses found to elapse before the action of the poison commenced; and such being the fact, we ought not perhaps to attach too great importance to the other argument I have employed,—the probability of disorder in the body and bed-clothes from the convulsions,—for if the poisoning commenced very soon, the convulsions might have been slight. The results of my own experiments related in page 694, although on the whole confirmatory of those of *Mr Macaulay* and his colleagues, are nevertheless sufficient to prove that large doses occasionally do not begin to operate with such rapidity as was observed in their experiments; for in one instance four drops of concentrated acid, equivalent to two scruples of medicinal acid, did not begin to act on a rabbit for twenty seconds; and certainly for so small an animal two scruples are as large a dose as five drachms for a grown-up girl.

The two following cases will throw some farther light on the time within which this poison begins to act on man when taken in large quantity. The first case shows, that even when an enormous dose is taken, a few simple voluntary acts may be executed before the symptoms begin. In this instance, which is related by *Dr Gierl* of Lindau, the dose was no less than four ounces of the acid of the Bavarian Pharmacopœia, which contains four per cent. of pure acid, and is equivalent to five ounces at least of the medicinal acid commonly used in Britain and France. The subject, an apothecary's assistant, was found dead in bed, with an empty two-ounce phial on each side of the bed,—the mattrass, which is used in Germany instead of blankets, pulled up as high as the breast,—the right arm extended straight down beneath the mattrass,—and the left arm bent at the elbow *. The second case proves that while one or two acts of volition may be accomplished, the interval is so very brief that these acts can only be of the simplest kind. An apothecary's apprentice-lad was sent from the shop to the cellar for some carbonate of potass; but he had not been a few minutes away when his companions heard him cry in a voice of great alarm, "Hartshorn! Hartshorn!" On instantly rushing down stairs, they found him reclining on the lower steps and grasping the rail; and he had scarcely time to mutter "Prussic acid!" when he expired,—not more than five minutes after leaving the shop. On the floor of the cellar an ounce-phial was found, which had been filled with the Bavarian hydrocyanic acid, but contained only a drachm. It appeared that he had taken the acid ignorantly for an experiment; and from the state of the articles in the cellar, it was evident that, alarmed at its instantaneous operation, he had tried to get at the ammonia, which he new was the antidote, but had found the tremendous activity of the poison would not allow him even to undo the coverings of the bottle †.

In the trial related above the prisoner Freeman was found *Not Guilty*.

It is important to fix, if possible, the smallest fatal dose of hydrocyanic acid. This will vary with particular circumstances, such as the strength of the individual, and the fulness or emptiness of the stomach at the time. The cases of the Parisian epileptics, however, will supply pointed information; for considering the long time they survived, it is not probable that a dose materially less would have a fatal effect on man. Each of them took twenty grains of the medicinal acid in the form of syrup, which quantity ought to have contained only two-thirds of a grain of pure acid *.

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* Medizinisch-chirurgische Zeitung, 1829, i. 396.

† *Buchner's* Repertorium für die Pharmacie, xxi. 318.

It is almost unnecessary to add, that in man, as in animals, this poison will act violently through whatever channel it may be introduced into the body. It is not ascertained positively that it will act with force through the unbroken skin. The chemist Scharinger indeed was supposed to have been killed in consequence of accidentally spilling the acid on his naked arm †; but this appears to have been in all probability a mistake. Should the skin be freely exposed to the air it seems reasonable to expect that the poison will evaporate before it could act with energy; but if confined by pledgets or otherwise, a different result might ensue. Through every other surface however besides the unbroken skin hydrocyanic acid acts with very great power; and it is in particular important to remember that its power is very great when inhaled, so that dangerous accidents have ensued even from its vapour incautiously snuffed up the nostrils. I have known a strong man suddenly struck down in this way; a French physician, *M. Damiron*, has related the case of an apothecary who remained insensible for half an hour subsequently to the same accident ‡; and cases of the kind are more apt to occur than might at first view be thought, because, contrary to what is generally believed and stated in chemical as well as medico-legal works, its smell is for a few seconds barely perceptible, and never of the kind which these accounts would lead one to anticipate.

The only case with which I am acquainted of poisoning with the artificial compounds of hydrocyanic acid is that formerly alluded to as having been occasioned by the hydrocyanate of potassa. Six grains of cyanide of potassium, dissolved in a clyster amounting to six ounces, occasioned general convulsions, palpitations, slow laboured breathing, coldness of the limbs, dilated pupil, fixing of the eyeballs, and death in one hour,—phenomena much the same with those produced by the acid itself[*]. In noticing this case Orfila draws the attention of practitioners particularly to the fact, that not long before a similar dose of a sample of cyanide, which had been moist for some time, was twice administered with impunity. The reason is that the cyanide of potassium is decomposed when acted on by water.

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* *Orfila*, Annales d'Hyg. Publ. et de Méd. Lég. i. 507.

† *Coullon*, Recherches, &c. p. 200.

‡ Journal de Chim. Médicale, vii. 426.

SECTION III.—*Of the Morbid Appearances produced by Hydrocyanic Acid.*

Under this head the appearances in a special case will first be mentioned, and then the varieties to which they are liable.

In *Hufeland's* case [p. 701] the inspection was made the day after death. The eyes were still glistening, like those of a person alive; but the countenance was pale and composed like one asleep. The spine and neck were stiff, the belly drawn in, the back alone livid. The body generally, the blood even within the head, and especially the cavities exhaled an odour of hydrocyanic acid, which was so strong as to irritate the nostrils. The blood was every where very fluid, so that two pounds flowed from the incision in the scalp and twelve ounces from that of the dura mater; and it had a glimmering bluish appearance, as if Prussian blue had been mixed with it. The vessels of the brain were gorged, the substance of the brain natural, and the left ventricle distended with half an ounce of serum. The villous coat of the stomach was red, easily removed with the nail, and gangrenous[†]. The intestines were reddish, and the liver gorged. The lungs were also turgid, and to such a degree in the depending parts as to resemble the liver. The arteries and left cavities of the heart were empty, the veins and right cavities distended.

In commenting on this description it is first to be remarked, that the blood, as in the preceding case, is generally altered in nature. *Ittner*, who has made some good experiments on the subject, found it in animals black, viscid, and oily in consistence[‡]. *Emmert* found it fluid and of a cochineel colour. In a case related by *Mertzdorff* of an apothecary's apprentice, who was found dead in bed after swallowing three drachms and a-half of diluted acid [*], in the case recorded in Horn's Archiv, and in that related by *Dr Gierl*, it was fluid. It was also perfectly fluid every where in the bodies of the seven epileptic patients poisoned at Paris. But this state is not invariable. *Coullon*, although his results tally in general with those of Ittner and Emmert, has given some experiments in which the blood coagulated after flowing from the body [†]; and in the case of an apothecary related in Rust's Journal it was found coagulated in the heart [‡].

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[*] Annales d'Hyg. Publique, &c. xi. 240.

[†] See *Note* at p. 438.

[‡] Beiträge zur Geschichte der Blausaüre, 1809.

In the next place, *Magendie* and other physiologists have observed that, as in Hufeland's case, the blood and cavities of the body in animals exhale a hydrocyanic odour, even though the quantity taken was small (see p. 697). The blood did so likewise in the heart of the apothecary just mentioned, as well as throughout the whole body in the case described in Horn's Journal. The odour, however, is not always present. For example there was none in the case of another German apothecary, who poisoned himself with an ounce, as recorded in a later volume of Rust's Journal [§]; neither was there any odour in the blood in *Mertzdorff's* case, although it was strong in the stomach; nor in the blood or any other part of the body in the Parisian epileptics. It also appears from an experiment by *Schubarth* [||], and from a case by *Leuret* where life was prolonged above fifteen minutes [¶],—that the odour may be distinct in the blood, brain, or chest, when hardly any is to be perceived in the stomach. Schubarth has inquired with some care into the circumstances under which the hydrocyanic odour may or may not be expected. He states, as the result of his researches, that if the dose is sufficient to cause death within ten minutes, the peculiar odour will always be remarked in the blood of the heart, lungs, and great vessels, provided the body have not been exposed to rain or to a current of air, and the examination be made within a moderate interval,—for example, twenty-one hours for so small an animal as a dog; but that, if the dose is so small that life is prolonged for fifteen, twenty-seven, or thirty-two minutes, then even immediately after death it may be impossible to remark any of the peculiar odour, evidently because, as already mentioned, (p. 696,) the acid is rapidly discharged by the lungs; and that even when the dose is large enough to cause death in four minutes, the smell may not be perceived if the carcase has been left in a spacious apartment for two days, or exposed to a shower for a few hours only. These facts explain satisfactorily why no odour could be perceived in the bodies of the Parisian epileptics; for they lived from half an hour to forty-five minutes. The poison may exist in the stomach, though not appreciable by the sense of smell. In *Chevallier's* case mentioned above, the contents of the stomach had not any odour of hydrocyanic acid; which, however, was evident to the sense of smell, and plainly indicated by various tests, in the fluid obtained by distilling the contents.

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[*] Journal Complémentaire, xvii. 366.

[†] Recherches, &c.

[‡] Magazin für die ges. Heilkunde, xiv. 104.

[§] Ibidem, xxiii. 375.

[||] Bemerkungen, &c. Hufeland's Journal, lii. i. 76.

[¶] Annales d'Hyg. Publ. et de Méd. Lég. iv. 422.

The presence of this odour in the blood may be accounted strong evidence of poisoning with hydrocyanic acid, if it is unequivocal to the sense of several individuals.—An exhalation of the same kind is occasionally formed by natural processes in the excrement. *Itard* once remarked in a case of inflammation of the intestines, and again in a case of inflamed liver, a strong smell of bitter almonds in the fæces, although no medicine containing hydrocyanic acid had been given *. This fact will render the inspector cautious, but can scarcely throw a doubt over the evidence from the odour in the blood or stomach.

In most instances,—for example, in the Parisian epileptics, the state of the brain, as to turgescence of vessels, has corresponded with the description given by *Hufeland*. Venous turgescence and emptiness of the arterial system is commonly remarked throughout the whole body. Thus in the epileptic patients, the heart and great arteries were empty; the great veins gorged; the spleen gorged, soft and pultaceous; the veins of the liver gorged; and the kidneys of a deep violet colour, much softened, and their veins gorged with black blood.

It is impossible that hydrocyanic acid could cause gangrene of the stomach, which is said to have been witnessed in Hufeland's case. But there are often signs of irritation in that organ. The villous coat has been found red in animals; it was shrivelled, and its vessels were turgid with black blood in the instance of the apothecary mentioned in the fourteenth volume of Rust's Journal; in *Mertzdorff's* case it was red and checkered with bloody streaks; and in the case related by *Dr Gierl*, where four ounces were swallowed, it was dark-red, as it were tanned or steeped in spirits, and easily separated from the subjacent contents. The contents of the stomach have in every instance had a strong hydrocyanic odour, except in the cases of the Parisian epileptics, and in those related by Leuret and by Chevallier. According to the experiments of Lassaigne and Schubarth, formerly noticed, it is not to be looked for when the body has been kept a few days, more especially when the individual lived some time. Even when the smell was strong in the stomach, *Coullon*, *Vauquelin*, and others have failed to detect the acid by chemical analysis. But their ill success may have arisen from imperfections in the method of analysis employed; for it was detected by the process formerly mentioned in the stomach of the apothecary last alluded to, in Chevallier's case, though not perceptible to the smell, and frequently by *Lassaigne* in animals.

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* Rust's Magazin, xx. 577.

Mertzdorff remarked both in his case of poisoning with hydrocyanic acid, and likewise in a parallel instance of poisoning with the essential oil of bitter almonds *, a singular appearance in the bile, the colour of which was altered to deep blue.

Coullon and *Emmert* say they have observed, that the bodies of animals resist putrefaction. The latter in particular mentions that he had left them several days in a warm room without perceiving any sign of decay. This certainly would not *a priori* be expected, considering the state of the blood. And it is not universal; for in one instance, the case of Mertzdorff, putrefaction commenced within thirty hours after death. In the Parisian epileptics, the bodies passed through the usual stage of rigidity.

It appears that even long after death the eye, as in Hufeland's case, has a peculiar glistening and staring expression, so as to render it difficult to believe that the individual is really dead; and this appearance has been considered by Dr Paris so remarkable, as even alone to supply " decisive evidence of poisoning by hydrocyanic acid [*]." But the accuracy of this opinion may be questioned. The appearance is indeed very general in cases of poisoning with preparations containing hydrocyanic acid. Besides occurring in the case of Hufeland, and in that which gave occasion to Dr Paris's statement, it was witnessed in that of Mertzdorff and in the instance described in Horn's Journal. But, on the one hand, it is not a constant appearance, for it was not observed in the seven Parisian epileptics. And on the other hand it is not peculiar, for death from carbonic acid has the same effect; I have remarked it very distinctly six hours after death in a woman who died of cholera; and it has been observed in cases of death during the epileptic paroxysm.

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* Journal Complémentaire, xvii. 366.

SECTION IV.—*Of the Treatment of Poisoning with Hydrocyanic Acid.*

Much attention has been lately paid to the treatment of this variety of poisoning; and the object of those who have studied it has naturally been the discovery of an antidote.

If it is true that hydrocyanic acid acts energetically in all its chemical combinations, and especially when united with alkalis, it is plain that no substance can perform the part of a chemical antidote, and consequently that, if an antidote exists at all, it must operate by exciting in the body an action contrary to that of the poison. Hence substances destitute of a rapid and powerful action on the system, such as oil, milk, soap, coffee, treacle, turpentine, and the like have been all found inert [†]; and, on the whole, the only remedies which appear to promise any material advantage have been the powerful and diffusible stimulants.

Of these *Ammonia* is considered by many the most energetic antidote. The first person who made careful experiments with it was *Mr John Murray* of London. After ascertaining the quantity requisite to kill an animal with certainty, he administered a fatal dose, and soon afterwards, applied ammonia assiduously to the nostrils of the animal; and he was so much struck with the beneficial effects, that he expressed himself ready to swallow a dose of the acid large enough to prove fatal, provided a skilful person were beside him to administer the antidote [*]. The favourable results obtained by Murray were afterwards confirmed by *M. Dupuy;* who found, that, when a horse had been twenty-five minutes under the influence of hydrocyanic acid and appeared about to perish, a drachm of carbonate of ammonia injected into the jugular vein restored it to health in a few minutes [†]. Afterwards, however, the efficacy of ammonia was called in question. *Orfila* stated in the third edition of his Toxicology that he had several times satisfied himself of the complete inutility of this as well as of many other antidotes [‡]. And *Dr Herbst* of Göttingen recently made some careful experiments, from which he concludes, that, although ammonia is useful when the dose of the poison is not large enough to kill, and will even make a rabbit that has taken a fatal dose jump up and run about for a little, yet it will never save the animal's life [§]. But farther experiments were made more lately by *Orfila*, who has in consequence been led to modify his former statement and to admit, that, although liquid ammonia is of no use when introduced into the stomach, yet if the vapour from it is inhaled, life may sometimes be preserved, provided the dose of the poison be not large enough to act with great rapidity. He remarked, that when from eight to fourteen drops of the medicinal acid were given to dogs of various sizes, they died in the course of fifteen minutes if left without assistance, but were sometimes saved by being made to inhale ammoniacal water, and recovered completely in little more than an hour [‖]. As this is very nearly the conclusion to which Mr Murray was led by his experiments performed in 1822, the latter gentleman is entitled to the entire merit of discovering the remedy. These experiments cannot have attracted in France the attention which they deserved, otherwise Mr Murray's claim would have been recognized by Professor Orfila. *Buchner*, it is right to add, had found this remedy useful in the same year in which Mr Murray's experiments were made [¶]. Orfila suggests a very important caution,—not to use a strong ammoniacal liquor, otherwise the mouth, air-passages, and even the alimentary canal may be attacked with inflammation, as indeed happened to the French physician whose case was formerly mentioned. The strong *aqua ammoniæ* should be diluted with twelve parts of water.

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[*] London Med. and Phys. Journal, lvii. 151.

[†] *Coullon*, Recherches sur l'Acide Hydrocyanique, 225, *et passim*.

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[*] Edin. Philosoph. Journal, vii. 124, and Edin. Journal of Science, ii. 214.

[†] Archives Gén. de Méd. xi. 30.

[‡] Toxicologie Générale, ii. 167.

[§] Archiv für Anatomie und Physiologie, 1828, p. 208.

[‖] Annales d'Hyg. Publ. et de Méd. Lég. i. 511.

[¶] Repertorium für die Pharmacie, xii. 144.

Another remedy of the same kind with ammonia as to action is *Chlorine*. This substance was first proposed as a remedy in 1822 by *Riauz*, a chemist of Ulm, who found that, when a pigeon was on the point of expiring after breathing the vapour of hydrocyanic acid, it immediately began to revive, on being made to breathe chlorine, and that in fifteen minutes it was able to fly away [*]. *Buchner* repeated Riauz's experiments and arrived at the same results. More lately *M. Simeon*, apothecary to the hospital of St Louis at Paris, apparently without being acquainted with the observations of the German chemists, was likewise led to suppose, that this gas might prove a useful antidote [†]; and *MM. Cottereau* and *Vallette* have formed the same conclusion [‡]. *Orfila* in his paper already quoted examines the merits of this remedy with great care, and infers that it is the most powerful antidote of all hitherto proposed. His experiments have convinced him, that animals, which have taken a dose of poison sufficient to kill them in fifteen or eighteen minutes, will be saved by inspiring water impregnated with a fourth part of its volume of chlorine, even although the application of the remedy be delayed till the poison has operated for four or five minutes. In some of his experiments he waited till the convulsive stage of the poisoning was passed, and the stage of flaccidity and insensibility had supervened; yet the animals were obviously out of danger ten minutes after the chlorine was first applied, and recovered entirely in three quarters of an hour [§].

The last remedy which deserves notice is the *Cold Affusion*. This was first recommended by *Dr Herbst* of Göttingen, who, on account of the success he witnessed from it in animals, considers it the best remedy yet proposed. When the dose of the poison was insufficient to prove fatal in ordinary circumstances, two affusions he found commonly sufficient to dispel every unpleasant symptom. When the dose was larger, it was necessary to repeat the affusion more frequently. Its efficacy was always most certain when resorted to before the convulsive stage of the poisoning was over; yet even in the stage of insensibility and paralysis it was sometimes employed with success. In the latter instance the first sign of amendment was renewal of the spasms of the muscles. Many experiments are related by the author in support of these statements. But the most decisive is the following. Two poodles of the same size being selected, the hydrocyanic acid was given to one of them in repeated small doses till it died. The whole quantity administered being seven grains of Ittner's acid, this dose was given at once to the other dog. Immediately it fell down in convulsions, violent opisthotonos ensued, and in half a minute the convulsive stage was followed by flaccidity, imperceptible respiration, and failing pulse. The cold affusion was immediately resorted to, but at first without any amendment. After the second affusion, however, the opisthotonos returned, and was accompanied by cries; and on the remedy being repeated every fifteen minutes, the breathing gradually became easier and easier, the spasms abated, and in a few hours the animal was quite well [*]. *Professor Orfila* has repeated Dr Herbst's experiments and obtained analogous results. He considers the cold affusion, however, to be inferior in power to chlorine [†].

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[*] Repertorium für die Pharmacie, xii. 141.

[†] Ibidem. xii. 144.

[‡] London Med. and Surg. Journal, iii. 58.

[§] Annales d'Hyg. Publ. et de Méd. Lég. i. 525.

On the whole, then, it appears that the proper treatment of a case of poisoning with hydrocyanic acid consists in the use of the cold affusion and the inhalation of diluted ammonia or chlorine: and as chlorine will hardly ever be at hand, ammonia will commonly be employed. Venesection is also probably indicated by the signs of congestion in the head.

It is right to remember, that, on account of the dreadful rapidity of this variety of poisoning, it will rarely be in the physician's power to resort to any treatment soon enough for success;—and farther, that his chance of success must generally be feeble even when the case is taken in time, because when hydrocyanic acid is swallowed by man, the dose is commonly so large as not to be counteracted by any remedies.

On the Vegetable Substances which contain Hydrocyanic acid.

Hydrocyanic acid exists in several plants; which are consequently poisonous. I have considered it advisable to describe their effects separately from those of the pure acid.

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[*] Archiv für Anatomie und Physiologie, 1828, p. 208.

[†] Annales d'Hyg. Publ. et de Méd. Lég. i. 518.

The plants which have been thoroughly examined and found to yield it belong to the division *Drupaceæ*, of Decandolle's Natural Family the *Rosaceæ*. These are the Bitter Almond, Cherry-laurel, Bird-cherry, and Peach, to which may be added the Mountain-ash or Rowan-tree. The poison procured from them exists in two forms,—as a distilled water, and as an essential oil.

The distilled waters yield hydrocyanic acid, as is shown by the blue precipitate they give with potass and acidulated sulphate of iron. They have a powerful, peculiar, grateful odour, which is usually likened to that of pure hydrocyanic acid. But the smell really bears very little resemblance to that of hydrocyanic acid, and is not owing to its presence: The odour remains equally strong after the acid is thrown down by the test now mentioned. The active part of the distilled water may be separated in the form of a volatile oil. This is colourless at first, afterwards reddish, acrid, bitter, heavier than water, and very volatile. The essential oil of the bitter almond has been carefully examined by various chemists. *Vogel* of Munich, by subjecting it twice to distillation from caustic potass, procured hydrocyanate of potass in the residue; and a volatile oil was distilled over, which no longer contained hydrocyanic acid, but nevertheless had the odour of the original oil [*]. This purified oil he considered equally poisonous with that which contains hydrocyanic acid, a single drop of it having killed a sparrow; and his opinion was confirmed by the experiments of *Professor Orfila*. But according to some careful experiments by *Stange*[†], which have been amply confirmed by *Dr Göppert* of Breslau[‡], and also by *MM. Robiquet* and *Boutron-Charlard*[§],—if the purified oil retains active poisonous properties, this must be owing to the acid not having been entirely removed. *Göppert* in particular remarked that twenty-five drops of the purified bitter almond oil, cherry-laurel oil, or bird-cherry oil had very little effect on rabbits, not more indeed than the same quantity of the common essential oils. The purified oil, according to all these chemists, possesses the odour of the original oil, as Vogel first stated.

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[*] Journal de Pharmacie, vii. 465.

[†] *Buchner's* Repertorium für die Pharmacie, xvi. 100.

[‡] *Rust's* Magazin für die gesammte Heilkunde, xxxii. 494.

[§] Annales de Chim. et de Phys. xliv. 352.

The crude oil, as prepared from the bitter almond, has been for some time known to possess the property of crystallizing when exposed to the air. These crystals were proved by *MM. Grischow* and *Bahlmann* *, and about the same time also by *Stange* †, to be the benzoic acid; but the latter adds, that, even after three months' exposure to the air, hydrocyanic acid exists in sufficient quantity to prove poisonous. The most interesting researches on the constitution and formation of this extraordinary oil are those lately conducted at Paris by *MM. Robiquet* and *Boutron-Charlard*. They confirmed the fact of its conversion into benzoic acid, and found that this acid does not exist in the oil ready-formed, but is produced by the gradual absorption of oxygen. They farther made some important observations, which will presently be mentioned, on the mode in which the crude oil is formed in the almond.

Of the Bitter Almond.

The Bitter Almond was once extensively used in Medicine, and is still very much employed by confectioners for flavouring puddings, sweetmeats, and liqueurs. It is the kernel of the fruit of the *Amygdalus communis*. This species has two varieties, the *dulcis* and the *amara;* which differ from one another in the fruit only. The fruit of the former yields the sweet, and of the latter the bitter almond. The bitter almond is the smaller of the two. The two plants, according to *Murray*, are convertible into each other,—the sweet variety becoming bitter by neglect,—the bitter becoming sweet by cultivation, or certain modes of management not well known,—and the seed of either variety producing plants of both ‡. These statements as to the mutual convertibility of the two varieties require confirmation.

The bitter almond depends for its activity on the essential oil, which is common to all the vegetable poisons belonging to the present tribe. According to the researches of *Robiquet* and *Boutron-Charlard*, the oil does not, like common essential oils, exist ready-formed in the almond, but is only produced when the almond-pulp comes in contact with water. It cannot be separated by any process whatever from the almond without the co-operation of water,—neither, for example, by pressing out the fixed oil, nor by the action of ether, nor by the action of absolute alcohol. A remarkable fact is, that, although after the almond is exhausted by ether, the remaining pulp gives the essential oil as soon as it is moistened, yet if it is also exhausted by alcohol, the essential oil is entirely lost; for it cannot be procured by any process either from the remaining pulp or from the matter dissolved by the ether or alcohol. Alcohol dissolves out a peculiar crystalline principle, named Amygdalin, the physiological properties of which are not yet ascertained.

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* Berlinisches Jahrbuch der Pharmacie, 1822, p. 158.

† *Buchner's* Repertorium, xiv. 329, xvi. 82.

‡ *Murray*, Apparatus Medicaminum, iii. 257.

In some respects, therefore, the essential oil of almonds is quite peculiar in its nature, and quite different from the common essential or volatile oils.—The presence of hydrocyanic acid in it is easily proved by dissolving it with agitation in water, and treating the solution with caustic potass, followed by sulphate of iron and sulphuric acid.—The quantity of essential oil which may be procured from the bitter almond amounts, according to *Krüger* of Rostock, to four drachms from five pounds or a ninety-sixth part *. The quantity of hydrocyanic acid in the oil varies considerably: *Schrader* got from an old sample 8.5 per cent., from a new sample 10.75 †; but *Göppert* got from another specimen so much as 14.33 per cent ‡.

Effects on Animals.—The bitter almond is a powerful poison, which acts in the same way as hydrocyanic acid, but likewise excites at times vomiting and other signs of irritation. The first good experiments on it are those related in *Wepfer's* treatise on the Cicuta; but its properties seem to have been known even to Dioscorides. The symptoms it induces in animals are trembling, weakness, palsy, convulsions, often of the tetanic kind, and finally coma. But frequently it occasions vomiting before these symptoms begin, and the animal in that way may escape §. According to Orfila, twenty almonds will kill a dog in six hours by the stomach if the gullet be tied; and six will kill it in four days when applied to a wound [*].

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* *Buchner's* Repertorium für die Pharmacie, xii. 135.

† *Fechner's* Repertorium der Organischen Chemie, ii. 65.

‡ *Rust's* Magazin für die gesammte Heilkunde, xxxii. 500.

§ *Wepferi*, Cicutæ aquaticæ Historia et noxæ, 244; and *Coullon*, Recherches sur l'Acide Hydrocyanique, 55.

The essential oil is not much inferior in activity to the pure hydrocyanic acid. A single drop of it applied by Mr Brodie on the tongue of a cat caused violent convulsions and death in five minutes [†]. But more generally a larger dose, or about seven drops, has been found necessary to kill a middle-sized dog. Five drops, according to *Göppert*, will kill a rabbit in six minutes. When entirely freed of hydrocyanic acid, it becomes, as already mentioned, not more poisonous than common volatile oils.

Symptoms in Man.—The effects of the almond and of the oil upon man are equally striking with those of hydrocyanic acid.

In small doses the bitter almond produces disorder of the digestive organs, nausea, vomiting, and sometimes diarrhœa. These symptoms are occasionally brought on by the small quantities used for flavouring sweetmeats, particularly when the confectioner has not been careful in compounding them. *Virey* says that accidents occasionally happen to children at Paris from their eating freely of macaroons, which are sometimes too strongly flavoured with the bitter almond [‡]. In this country accidents from the same cause may be with justice apprehended, as confectioners are getting into the practice of using not the bitter almond, but its essential oil, which is now distilled in large quantity in London, and sold habitually in the druggists' shops under the name of Peach-nut oil. This oil, as *Göppert* properly suggests, ought to be freed of its hydrocyanic acid by repeated distillation with caustic potassa, because the flavour is not in the least injured by the process, while its activity as a poison is greatly lessened.

In peculiar constitutions the minutest quantity, even a single almond, will cause a state resembling intoxication, succeeded by an eruption like nettle-rash. The late Dr Gregory was subject to be affected in this way. Other vegetable bitters had the same effect on him, but none so remarkably as bitter almonds. They caused first sickness, generally tremors, then vomiting, next a hot fit with an eruption of urticaria, particularly on the upper part of the body. At the same time the face and head swelled very much, and there was generally a feeling like intoxication. The symptoms lasted only for a few hours. The rash did not alternately appear and disappear as in common nettle-rash [*]. A lady of my acquaintance is liable to be attacked with urticaria even from eating the sweet almond.

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[*] Toxicologie Générale, ii. 179.

[†] Philosophical Transactions, 1811; p. 184.

[‡] Journal de Pharmacie, ii. 204.

The quantity of bitter almonds which may be eaten with impunity is unknown; but *Wibmer* mentions an experimentalist who took half an ounce without any other effect besides headach and sickness [†]. Two cases of death in the human subject from eating them have been quoted by *Coullon* from the Journal de Médecine of Montpellier. One is a doubtful case; but the other is unequivocal. A bath-woman gave her child the "expressed juice" of a handful of bitter almonds to cure worms. The child, who was four years old, was immediately attacked with colic, swelling of the belly, giddiness, locked-jaw, frothing at the mouth, general convulsions, and insensibility, and died in two hours [‡]. *Murray*, however, asserts in his Apparatus Medicaminum that the expressed juice is sweet and not poisonous [§]. But this apparent contradiction is easily explained by referring to the researches of *Robiquet* and *Boutron-Charlard*,—the oil expressed without water being free from essential oil, while the milky fluid expressed from the pulp beat up with water is strongly impregnated with it.—Another case was published not long ago by *Mr Kennedy* of London; but the symptoms were imperfectly ascertained. The person, a stout labourer, appeared to have eaten a great quantity of bitter almonds, which were subsequently found in the stomach. He was seen to drop down while standing near a wall, soon after which the surgeon who was sent for found him quite insensible, with the pulse imperceptible, and the breath exhaling the odour of bitter almonds; and death took place in no long time [‖].

Coullon has noticed many other instances where alarming symptoms were produced by this poison, but were dissipated by the supervention of spontaneous vomiting.

The effects of small doses of the oil have been tried by Mr

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[*] *Dr Alison's* Manuscript Lectures.

[†] Die Wirkung der Arzneimittel und Gifte, i. 166.

[‡] Recherches, &c. 60.

[§] Apparatus Medicaminum, iii. 257.

[‖] London Med. and Phys. Journal, lvii. 150.

Brodie on himself; and a fatal case of poisoning with it has been recorded by Mertzdorff. In the course of his experiments *Mr Brodie* once happened to touch his tongue with the end of a glass rod which had been dipped in the oil; and he says he had scarcely done so before he felt an uneasy, indescribable feeling in the pit of the stomach, great feebleness of his limbs, and loss of power to direct the muscles, so that he could hardly keep himself from falling. These sensations were quite momentary*.

Mertzdorff's case is interesting, not only as being accurately related, but likewise on account of the exact resemblance of the symptoms to those observed in the celebrated case of Sir Theodosius Boughton, which will presently be mentioned. A hypochondriacal gentleman, 48 years old, swallowed two drachms of the essential oil. A few minutes afterwards, his servant, whom he sent for, found him lying in bed, with his features spasmodically contracted, his eyes fixed, staring, and turned upwards, and his chest heaving convulsively and hurriedly. A physician, who entered the room twenty minutes after the draught had been taken, found him quite insensible, the pupils immoveable, the breathing stertorous and slow, the pulse feeble and only 30 in a minute, and the breath exhaling strongly the odour of bitter almonds. Death ensued ten minutes afterwards †.—A fatal case occurred lately in London, where the individual, intending to compound a nostrum for worms with Beech-nut oil, got by mistake from the druggist Peach-nut oil, which is nothing else than the oil of bitter almond.

The morbid appearances are the same as in poisoning with the pure acid. In Mertzdorff's case the whole blood and body emitted a smell of almonds; putrefaction had begun, though the inspection was made twenty-nine hours after death; the blood throughout was fluid, and flowed from the nostrils and mouth; the veins were every where turgid; the cerebral vessels gorged; the stomach and intestines very red.—In the case from the Medical and Physical Journal of poisoning with the almond itself, the vessels of the brain were much gorged, and the eyes glistening and staring as if the person had been alive.

Of the Cherry-Laurel.

The Cherry-Laurel, or *Prunus Lauro-cerasus*, was at one time much used for flavouring liqueurs and sweetmeats. But it is now less employed than formerly, as many fatal accidents have happened from its having been used in too large quantity. The custom, however, has not been altogether abandoned; for there is an account in an English newspaper in 1823 of two persons killed by ratifia'd brandy, which had been flavoured with this plant; and *Dr Paris* has mentioned an instance of several children at an English boarding-school having been dangerously affected by a custard flavoured with the leaves *. Almost every part of the plant is poisonous, especially the leaves and kernels; but the pulp of the cherry is not. The flower has a totally different odour from the leaves. The healthy vigorous shoots in the early part of summer, and the inner bark, both then and in autumn, smell strongly of the bitter almond when broken across. The kernels of the seeds have a strong taste of bitter almonds. —The plant yields a distilled water and an essential oil, which *Robiquet* found to have all the chemical properties of the oil of bitter almond †.

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* Philosophical Transactions, 1811, p. 183.

† Journal Complémentaire, &c. xvii. 366.

Cherry-laurel oil, according to *Schrader*, contains 7.66 per cent. of hydrocyanic acid ‡; but according to *Göppert*, a specimen supposed to be genuine gave only 2.75 per cent. §. It is probably therefore a weaker poison than the oil of bitter almond.—The latest experiments made with this oil are those of some Florentine physicians, performed at the laboratory of the Marquess Rodolphi, and described by *Professor Taddei* ‖. Sixteen drops put on the tongue of rabbits killed them in nine, fifteen, or twenty minutes; and ten or twelve drops injected in oil into the anus killed them in four minutes. The symptoms were slow breathing, palsy of the hind-legs, then general convulsions; and death was preceded by complete coma. A very extraordinary appearance was found in the dead body,—blood extravasated abundantly in the trachea and lungs.

The Cherry-Laurel Water, prepared by distillation from the leaves of this plant, was long the most important of the poisons which contain the hydrocyanic acid, as it was the most common before the introduction of the acid itself into medical practice. Water dissolves by agitation 3.25 grains of oil per ounce; which may be considered the proportion in a saturated distilled water. The water contains, according to *Schubarth*, only 0.25 per cent. of hydrocyanic acid [*]; according to *Schrader* [†] only half as much; and by long keeping even that small proportion will gradually disappear, as I have ascertained by experiment. Hence its strength must vary greatly,—a fact which seems indispensable for explaining the very different effects of the same dose in different instances.

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* Medical Jurisprudence, ii. 402.

† Journal de Pharmacie, viii. 304.

‡ *Buchner's* Repertorium, xii. 130.

§ *Rust's* Magazin für die gesammte Heilk. xxxii. 497.

‖ Bericht über einige Versuche über die Wirkung des Oleum Essentiale Laurocerasi.—*Hufeland's* Journal der Praktischen Heilkunde, liv. iii. 27.

From experiments on animals by a great number of observers, it appears that, whether it is introduced into the stomach, or into the anus, or into the cellular tissue, or directly into a vein, it occasions giddiness, palsy, insensibility, convulsions, coma, and speedy death;—that the tetanic state brought on by the pure acid, is not always so distinctly caused by cherry-laurel water;—and that tetanus is most frequently induced by medium doses.

The attention of physicians was first called to this poison by an account published by *Dr Madden* in the Philosophical Transactions for 1737, of several accidents which occurred at Dublin in consequence of strong ratifia'd brandy having been prepared with it. *Foderé* has also given an account of two cases, caused by servants having stolen and drunk a bottle of it, which they mistook for a cordial [‡]. Being afraid of detection, they swallowed it quickly, and in a few minutes expired in convulsions. *Murray* has noticed several others in his Apparatus Medicaminum [§]. In most of these cases the individuals suddenly lost their speech, fell down insensible, and died in a few minutes. Convulsions do not appear to have been frequent. *Coullon* has also related an instance where a child seems to have been killed by the leaves applied to a large sore on the neck [‖].

The dose required to occasion these effects, and more especially to prove fatal, has not been determined with care. It must vary with the age of the sample used. It will vary also according as the water has been filtered or not; for what is not filtered often presents undissolved oil suspended in it or floating on its surface. One ounce has proved fatal [*]; and half an ounce has caused only temporary giddiness, loss of power over the limbs, stupor, and sense of pressure in the stomach [†].

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[*] Bemerkungen, &c. Journal der Praktischen Heilkunde, li. i. 125.

[†] *Fechner's* Repertorium der Org. Chemie, ii. 65.

[‡] Médecine Légale, iv. 27.

[§] Apparatus Medicaminum, iii. 216.

[‖] Recherches, &c. p. 95.

The appearances found in the dead body have varied. In general the blood has been fluid. The smell of bitter almond has commonly been distinct in the stomach.

The Cherry-laurel water has attracted a great deal of attention in this country, in consequence of being the poison used by Captain Donnellan for the murder of Sir Theodosius Boughton. The trial of Donnellan, the most important trial for poisoning which ever took place in Britain, has given rise to some discrepance of opinion both among barristers and medical men, as to the sufficiency of the evidence by which the prisoner was condemned [‡]. For my part, taking into account the general, as well as medical circumstances of the case, I do not entertain a doubt of his guilt.

Leaving the general evidence out of view, however, as foreign to the objects of the medical jurist's regard, it must be admitted that the medical evidence was defective. It may be summed up shortly in the following terms:—Sir Theodosius was a young man of the age of twenty, and in perfect health, except that he had a slight venereal complaint of old standing, for which he occasionally took a laxative draught. On the morning of his death, his mother, Lady Boughtón, remarked, while giving him his draught, that it had a strong smell of bitter almonds. Two minutes after he took it, she observed a rattling or gurgling in his stomach; in ten minutes more he seemed inclined to doze; and five minutes afterwards she found him quite insensible, with the eyes fixed upwards, the teeth locked, froth running out of his mouth, and a great heaving at his stomach and gurgling in his throat. He died within half an hour after swallowing the draught. The body was examined ten days after death, and the inspectors found great congestion of the veins every where, gorging of the lungs, and redness of the stomach. But the examination was unskilfully conducted. For the head was not opened; the fæces were allowed to rush from the intestines into the stomach; and, as a great quantity of fluid blood was found in each cavity of the chest, the subclavian veins must have been divided during the separation of the clavicles. Very little reliance, therefore, can be placed in the evidence from the inspection of the body *.

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[*] Philosophical Transactions, 1739, No. 452.

[†] *Wibmer*, die Wirkung der Arzneimittel und Gifte, ii. 90.

[‡] Considerations on the criminal proceedings of this country, on the danger of convictions on circumstantial evidence, and on the case of *Mr Donnellan*. By a Barrister of the Inner Temple, 1781.—*Phillips'* Treatise on the Law of Evidence, Appendix, p. 30.—*Male's* Juridical Medicine, p. 86.—These authorities all consider the guilt of the prisoner doubtful.

On comparing these particulars with what has been said above of the effects of hydrocyanic acid and of this whole genus of poisons, it will be seen that every circumstance coincides precisely with the supposition of poisoning with cherry-laurel water. The symptoms were exactly the same as in Mertzdorff's case of poisoning with the essential oil of almonds (p. 721). When to this are added, the smell of the draught, which Lady Boughton could hardly mistake, the rarity of apoplexy in so young and healthy a person as Sir Theodosius, and the improbability of either that or any other disease of the head proving fatal so quickly,—the conclusion at which, in my opinion, every sound medical jurist must arrive is, that poisoning in the way supposed was very probable. But I cannot go along with those who think that it was certain; nor is it possible to see on what grounds such an opinion can be founded, when the general or moral circumstances are excluded.

The medical evidence in Donnellan's case has been much canvassed, and especially that of Mr John Hunter. It would be foreign to the plan hitherto pursued in this work to analyze and review what was said by him and his brethren. But I must frankly observe, that Mr Hunter's evidence does him very little credit, and that his high professional eminence is the very reverse of a reason for palliating his errors, or treating them with the lenity which they have experienced from his numerous critics.

Of the Peach, Cluster-Cherry, Mountain-Ash, &c.

Little need be said of the other plants formerly mentioned among those which yield hydrocyanic acid, and act on the system in consequence of containing that substance.

The *Amygdalus Persica* or peach is the most active of them.

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* Trial, &c. taken in short hand by *Gurney*.

Most parts of the plant exhale the odour of the bitter-almond, but particularly the flowers and kernels. According to the chemical researches of *M. Gauthier*, the fresh young shoots of the peach collected in July contain, weight for weight, even more essential oil than the bitter almond, or cherry-laurel leaves; for 250 grains yielded nearly five grains of it or two per cent; and he found the oil may be easily procured by distilling the shoots without addition till the product begins to pass over clear [*].

Coullon has collected two fatal cases of poisoning with the peach-blossom. One is the case of an elderly gentleman, who swallowed a sallad of the flower to purge himself. Soon afterwards he was seized with giddiness, violent purging, convulsions, and stupor; and he died in three days. Here the poison must have proved fatal by inducing true apoplexy in a predisposed habit: at least poisoning with hydrocyanic acid never lasts nearly so long. The other, a child eighteen months old, after taking a decoction of the flowers to destroy worms, perished with frightful convulsions, efforts to vomit, and bloody diarrhœa [†]. The peach-blossom would therefore appear to be rather a narcotico-acrid, than a pure narcotic.

The bark of the *Prunus Padus*, or Cluster-Cherry, a native of this country, owes its poisonous qualities to the same substance as the preceding plants. Its distilled water has the odour of bitter almonds, contains the same essential oil with that of the bitter almond, and yields more hydrocyanic acid than the cherry-laurel water [‡]. The oil, according to *Schrader*, contains 9.25 [§] per cent. of hydrocyanic acid, according to *Göppert* only 5.5 per cent [‖]. *Bremer*, who has examined this plant with great care, found that both the distilled water and the essential oil kill mice when put into the mouth, eye, nose, ear, anus, or a wound; and that half an ounce of the water killed a dog in twelve minutes [¶]. The fruit is also poisonous. It has a nauseous taste, but communicates a pleasant flavour to spirituous liquors. The kernels yield by expression a transparent, fixed oil, concrete at 41° F., which contains a small quantity of the essential oil; and the cake which is left yields so much of the latter, that, as we are informed by *M. Chancel* of Briançon, a handful has proved fatal to cows in a short time [*]. It is probable that in these kernels, as in the bitter almond, the essential oil does not exist ready-formed, but is developed only in consequence of the contact of water; and that if the fixed oil by expression contains a little of it, as Chancel says, this must arise from the kernels having been moist when squeezed.

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[*] Buchner's Repertorium für die Pharmacie, xxviii. 416.

[†] Recherches, &c. p. 74.

[‡] *Bremer*, Bemerkungen und Erfahrungen über die Wirksamkeit des Trauben-Kirschbaums.—Archiv für Medizinische Erfahrung, 1812, i. 41.

[§] *Buchner's* Repertorium, xii. 130.

[‖] *Rust's* Magazin, xxxii. 500.

[¶] Bemerkungen, &c. *Horn's* Archiv, 1812, i. 71.

The *Sorbus Aucuparia*, Mountain-ash or Rowan-tree, as it is called in Scotland, has been lately added to the list of plants which abound in the same poisonous principle. *M. Grassmann* of St Petersburg has found that many parts of this tree, such as the flowers and the bark of the trunk and branches, contain more or less of the peculiar essential oil; and that the root in particular contains so much in the month of May as to smell strongly of it when broken across, and to yield a distilled water which holds fully as much hydrocyanic acid as that procured from an equal weight of cherry-laurel leaves [†].

Several other plants of the same natural order possess similar though weaker properties, such as the *Prunus Avium*, or black-cherry, or mazzard, the *Prunus Insititia*, or bullace, the *Prunus spinosa*, or sloe, the *Amygdalus nana*, or dwarf-almond, and even the leaves and kernels of the common cherry, the *Prunus Cerasus*. It is also probable that the seeds of the Pomaceæ, such as even the seeds of the apple and pear, have the same qualities, for they have the same odour and taste; but they have not been particularly examined.

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[*] Journal de Pharmacie, iii. 275.

[†] *Buchner's* Repertorium für die Pharmacie, xxvii. 238.

CHAPTER XXX.

OF POISONING WITH CARBAZOTIC ACID.

A SUBSTANCE long known to chemists by the name of Indigo-Bitter, which is procured by the action of nitric acid on indigo, silk, and other azotized substances, and which has been found to consist chiefly of a peculiar acid, termed by *Liebig*, from its composition, the Carbazotic acid, appears to be a pure narcotic poison of considerable activity*. It is in the form of shining crystals, of an excessively bitter taste, and of a yellow colour so singularly intense that it imparts a perceptible tint to a million parts of water. The pure crystals are composed of carbon, azote, and oxygen.

The only account I have seen of the physiological properties of this substance is a full analysis by *Buchner* in his Toxicology, of some interesting experiments by *Professor Rapp* of Tübingen†. He found that sixteen grains in solution, when introduced into the stomach, killed a fox, ten grains a dog, and five grains a rabbit, in an hour and a-half; that the injection of a watery solution into the windpipe occasioned death in a few minutes; that the introduction of it into the cavity of the pleura or peritonæum occasioned death in several hours; that a watery solution of ten grains injected into the jugular vein of a fox killed it instantaneously, and in like manner five grains affected a dog in three minutes and killed it in twenty-four hours; and that thirty grains applied to a wound killed a rabbit. The symptoms remarked from its introduction into the stomach of the fox were in half an hour tremors, grinding of the teeth, constant contortion of the eyes and convulsions, in an hour complete insensibility, and death in half an hour more. In the dog there was also remarked an attack of vomiting and feebleness of the pulse.

In the dead body no particular alteration of structure was remarked. The heart examined immediately after death from the introduction of the poison into the stomach was found much gorged and motionless; but the irritability of the voluntary muscles remained. The stomach was not inflamed, but dyed yellow. A very interesting appearance was dyeing of various textures and fluids throughout the body. In the fox killed by swallowing sixteen grains the conjunctiva of the eyes, the aqueous humour, the capsule of the lens, the membranes of the arteries, and in a less degree that of the veins, the lungs, and in many places the cellular tissue, had acquired a lemon-yellow colour. The dog killed in the same manner presented similar appearances, also animals killed by injection of the poison into the pleura or peritonæum; and in the latter animals the urine was tinged yellow. In a rabbit killed by the application of the poison to a wound the same discoloration was also every where remarked, together with yellowness of the fibrin of the blood. But no yellowness could be seen any where in the dog, which died in twenty-four hours after receiving five grains into the jugular vein. In no instance was there any yellow tint perceptible in the brain or spinal chord.

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* Annales de Chim. et de Phys. xxxv. 72.

† Toxikologie, 373.

These facts form one of the most interesting additions made in recent times to the physiology of poisons. They supply unequivocal proof that some poisons are absorbed in the course of their operation, and may be found throughout the body after death. They likewise furnish strong presumptive evidence that, as formerly hinted, other poisons, which act on organs remote from the place where they are applied, and which have been sought for without success in the blood as well as in other fluids and solids throughout the body, have not been detected, merely because the physiologist does not possess such simple and extremely delicate means of searching for them.

The researches of Professor Rapp have been arranged under the title of carbazotic acid, because this acid forms the most prominent substance in the matter with which his experiments appear to have been made. But it is right to state, that the article actually used was, if I understand correctly the abstract given by Buchner, not the pure crystals, but the yellow fluid, from which the crystals are procured, and which contains also a resinous matter and artificial tannin.—The bitter principle of *Welther* procured by the action of nitric acid on silk, and that formed by *Braconnot* by the action of the same acid on aloes, appear to be impure carbazotic acid.

CHAPTER XXXI.

OF THE POISONOUS GASES.

The subject of the Poisonous Gases is one of great importance in relation to Medical Police, as well as Medical Jurisprudence. They are objects of interest to the medical jurist, because their effects may be mistaken for those of criminal violence, and because they have even been resorted to for committing suicide. They are interesting as a topic of medical police, since some trades expose the workmen to their influence.

It has hitherto been only on the continent that use has been made of the deleterious gases for the purpose of self-destruction. *Osiander* mentions, that Lebrun, a famous player on the horn, suffocated himself at Paris in 1809 with the fumes of sulphur; and that an apothecary at Pyrmont killed himself by going into the *Grotto del Cane* there, which, like that near Naples, is filled with carbonic acid gas [*]. A late French journal relates the case of a young man who, urged by disappointment in love, tried to make away with himself by burning a charcoal choffer in his apartment [†].

But these poisons come under the notice of the medical jurist chiefly because their effects may be mistaken for those of other kinds of violent death. Several mistakes of this nature are on record. *Zacchias* mentions the case of a man, who was found dead in prison under circumstances which led to the suspicion that he had been privately strangled by the governor. But Zacchias proved this to be impossible, and ascribed death to the fumes from a choffer of burning charcoal left in the room [‡]. A more striking instance of the kind occurred lately at London. A woman, who inhabited a room with other five people, alarmed the neighbours one morning with the intelligence that all her fellow-lodgers were dead. On entering the room they found two men and two women actually dead, and another man quite insensible and apparently dying. This man, however, recovered; and as it was said that he was too intimate with the woman who gave the alarm, a report was spread that she had poisoned the rest, to get rid of the man's wife, one of the sufferers. She was accordingly put in prison, various articles in the house were carefully analyzed for poison, and an account of the supposed barbarous murder was hawked about the streets. At last the man who recovered remembered having put a choffer of coals between the two beds, which held the whole six people; and the chamber having no vent, they had thus been all suffocated [*].—The following is a similar accident not less remarkable in its circumstances. Four people in *Gerolzhofen* in Bavaria, were found one morning in bed, some dead, others comatose. One only recovered. A neighbour who had supped with them, but slept at home, did not suffer. The stomach and intestines were found very red and black; and the coats of the stomach brittle. The contents of the stomach, the remains of their supper, and the wine were analyzed without any suspicious substance being found. A little smoke having been noticed in the room by those who first entered it, the stove and fuel were examined, but without furnishing any insight into the cause of the accident. At last the cellar was examined, and then it was found that one of the sufferers had heated a copper-vessel there so incautiously, that the fire communicated with the unplastered planks of the floor above. The planks had burnt with a low smothered flame, and the vapours passed through the crevices in the floor [†].

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[*] Ueber den Selbstmord, p. 176.

[†] Nouv. Bibl. Méd. 1827, iii. 91.

[‡] Quæstionum Medico-legalium, T. iii. 63. *Consilium* 44.

On the question—What Irrespirable Gases are Poisonous?

Some gases act negatively on the animal system by preventing the access of respirable air to the lungs; others are positively poisonous. The first point, therefore, is to ascertain which are negatively, and which positively hurtful.

M. Nysten, who has made the most connected train of experiments on this subject, conceived that a gas will not act through any other channel besides the lungs, if it exerts merely a negative action;—and that, on the contrary, it certainly possesses a direct and positive power, if it has nearly the same effects, in whatever way it is introduced into the body [‡]. He therefore thought the best way to ascertain the action of the gases would be, to inject them into the blood,—conceiving that, after allowance is made for the mere mechanical effects of an aeriform body, the phenomena would point out the true operation of each.

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[*] London Courier, Jan. 16, 1823.

[†] *Buchner's* Toxikologie, 331.

[‡] Nysten, Recherches Chimico-Physiologiques, p. 11.

His first object then was to learn what phenomena are caused by the mechanical action of atmospherical air. He found that four cubic inches and a half injected into the jugular vein of a dog, killed it immediately amidst tetanic convulsions, by distending the heart with frothy blood;—that a larger quantity introduced gradually caused more lingering death, with symptoms of oppressed breathing, which arose from gorging of the lungs with frothy blood;—and that a small quantity injected into the carotid artery towards the brain occasioned speedy death by apoplexy, which arose from the brain being deprived by means of the air of a due supply of its proper stimulus, the blood.

Proceeding with these data, he found that *Oxygen* and *Azote* had the same effect when apart, as when united in the form of atmospheric air; that *Carburetted hydrogen*, *Hydrogen*, *Carbonic oxide*, and *Phosphuretted hydrogen* likewise act in the same way; and that the *Nitrous oxide*, or intoxicating gas, although it does not cause so much mechanical injury as the others on account of its superior solubility in the blood, has the same effect when injected in sufficient quantity, and produces little or none of the symptoms of intoxication excited by it in man[*]. As to *Carbonic acid gas*, he found that, on account of its great solubility in the blood, it is difficult to produce mechanical injury with it; that sixty-four cubic inches are absorbed, and do not excite any particular symptoms; but that when injected into the carotid artery, it occasions death by apoplexy, although it is rapidly absorbed by the blood[†].

The other gases he tried were sulphuretted hydrogen, nitric oxide, ammonia, and chlorine; and all of these proved to be positively and highly deleterious.

Two or three cubic inches of *Sulphuretted Hydrogen* caused tetanus and immediate death, when injected into the veins, although the gas was at once absorbed by the blood. The same quantity acted with almost equal rapidity when injected into the cavity of the chest. Similar results were obtained when it was injected into the cellular tissue, or even when it was left for some time in contact with the sound skin [*]. The last important fact has been since confirmed by *Lebküchner* in his Thesis on the Permeability of the tissues [†]; and it had previously been observed also by the late *Professor Chaussier*, whose experiments will be mentioned presently, (p. 738.) In none of Nysten's experiments with this gas was the blood changed in appearance.

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[*] Nysten, Recherches Chimico-Physiologiques, *passim*.

[†] Ibidem, p. 81.

Nitric oxide gas, according to Nysten, is the most energetic of all the poisonous gases. A very small quantity causes death by tetanus, when introduced into a vein, the cavity of the chest, or the cellular tissue; and it always changes the state of the blood, giving it a chocolate-brown colour, and preventing its coagulation. In one of Nysten's experiments a cubic inch and three quarters injected into the chest killed a little dog in 45 minutes [‡]. *Dr John Davy* appears to have found this gas not so active [§].

Nysten found the two other gases, *Ammonia* and *Chlorine*, to be acrid in their action. When injected into the veins they kill by over-stimulating the heart; and when injected into the cavity of the chest, they excite inflammation in the lining membrane [||]. *Hébréart* farther remarked in his experiments relative to the action of irritants on the windpipe, that chlorine when inspired, produces violent inflammation in the windpipe and its great branches, ending in the secretion of a pseudo-membrane like that of croup [¶]; and that a very small quantity of ammonia has the same effect.

From this abstract of Nysten's researches, it appears to follow, that ammonia and chlorine are irritants; sulphuretted hydrogen and nitric oxide, narcotics; oxygen, azote, hydrogen, carburetted hydrogen, phosphuretted hydrogen, carbonic oxide, and nitrous oxide, negative poisons; and carbonic acid, doubtful in its nature. Some of these conclusions do not correspond with the effects observed in man; which will presently be found to lead to the inference, that not only carbonic acid, but likewise carbonic oxide, nitrous oxide, and carburetted hydrogen are narcotics. The reason Nysten did not find these gases injurious was probably, that, before they could pass from the vein into which they were injected, to the brain on which they act, they were in a great measure exhaled from the lungs. The experiments of physiologists since *Nysten's* time likewise tend to show that oxygen gas is a positive poison when pure, and that even hydrogen possesses active properties. In the late inquiries of *Mr Broughton*, that gentleman was led to consider hydrogen a positive poison, because animals die in it in half a minute, and the heart immediately after death is found to have lost its contractility. Previous experimentalists had also remarked hypnotic effects from the inhalation of it diluted with oxygen [*]. As to oxygen, the same physiologist ascertained that when pure, it is a narcotic poison; but that it is feeble in its operation, as at least five hours of continuous respiration in the pure gas are required to prove fatal [†].

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[*] Rech. Chimico-Physiologiques, p. 114.

[†] Diss. Inaug. utrum, per viventium adhuc animalium membranas materiæ ponderabiles permeare queant. Tubingæ, p. 10.

[‡] Nysten, Recherches, &c. p. 137.

[§] Philosophical Transactions, cxiii. 508.

[||] Nysten, Recherches, &c. p. 140.

[¶] *Corvisart's* Journal de Méd. xxiv. 249.

Of the Effects of the Poisonous Gases on Man.

According to the effects of the poisonous gases on man, they may be arranged in two groupes, the first including the *Irritants*, the second the *Narcotics*. It might have been therefore a more philosophical mode of arrangement, if the former had been considered under the irritant class of poisons; but it is more convenient to examine the whole deleterious gases together.

The *Irritant Gases* are nitric oxide gas and nitrous acid vapour, muriatic acid gas, chlorine, ammonia, sulphurous acid, and some others of little consequence.

Of Nitric oxide gas and Nitrous acid vapour.—Before Nitric oxide gas can be breathed in ordinary circumstances, it is transformed by the oxygen of the air into nitrous acid vapour, of a ruddy colour and irritating odour. Hébréart found that in animals killed by inhaling it the windpipe was much inflamed [‡].

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[*] *Allen* and *Pepys*, also *Wetterstedt*. See *Dr Apjohn's* article on Toxicology in Cycl. of Pract. Med. iv. 238.

[†] London Quarterly Journal of Science, vi. N. S.

[‡] Corvisart's Journal de Med. xxiv. 246.

Sir H. Davy tried to inhale it, and with this view used the precaution of previously breathing the nitrous oxide or intoxicating gas, in order to expel the atmospheric air as much as possible from his lungs. But he found that the small quantity of nitrous acid fumes formed with the remaining air was sufficient to cause a sense of burning in the throat, and at once stimulated the glottis to contract, so that none of the nitric oxide gas could pass into the larynx. The subsequent entrance of the external air into the mouth, which Sir Humphrey unluckily had not foreseen, was of course attended by the immediate formation of more acid fumes, by which his tongue, cheeks, and gums, were irritated and inflamed; and there is no doubt, as Sir Humphrey himself remarks, that if he had succeeded in inhaling the nitric oxide gas, the same chemical change would have happened in the lungs and excited severe pneumonia [*].

The following cases will prove that Nitrous Acid vapour, disengaged from the fuming nitrous acid, is a very violent and dangerous poison when inhaled. A chemical manufacturer, in endeavouring to remove from his store-room a hamper in which some bottles of nitrous acid had burst, breathed the fumes for some time, and was seized in four hours with symptoms of inflammation in the throat and stomach. At night the urine was suppressed; the skin afterwards became blue; at last he was seized with hiccup, acute pain in the diaphragm, convulsions, and delirium; and he died twenty-seven hours after the accident [†].—Another case has been described in the Bulletins of the Medical Society of Emulation. It proved fatal in two days, and the symptoms were those of violent pneumonia. In this instance there was peripneumony of one side, and pleurisy of the other; the uvula and throat were gangrenous, and the windpipe and air-tubes dark-red; the veins throughout the whole body were much congested, the skin very livid in many places, and the blood fluid in the heart, but coagulated in the vessels [‡]. *Dr Reitz*, a writer in Henke's Journal, met with two cases of death from the same cause in hatters. They had incautiously exposed themselves too much to the fumes, which are disengaged during the preparation of nitrate of mercury for the felting of the furs, and which are well-known to be nitric oxide gas converted into nitrous acid vapour by the contact of the air. Two men died of inflammation of the lungs excited in that manner; and a third, a boy of fourteen, after sleeping all night in an apartment where the mixture was effervescing, was attacked in the morning with yellowness of the skin, giddiness, and colic, which ended fatally in six days *.

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[*] Researches, Chemical and Philosophical, concerning nitrous oxide gas, p. 475.

[†] *Desgranges* in Corvisart's Journal de Med. viii. 487.

[‡] Bulletins de la Soc. Med. d'Emulation, Oct. 1823.

Of Poisoning with Chlorine.—The experiments of Nysten and Hébréart with chlorine, and its well-known irritating effects when inhaled in the minutest quantities, show that it will produce inflammation of the lungs and air-passages. The following is the only instance of poisoning with it in man which has come under my notice. A young man, after breathing diluted chlorine as an experiment, was instantly seized with violent irritation in the epiglottis, windpipe, and bronchial branches, cough, tightness, and sense of pressure in the chest, inability to swallow, great difficulty in breathing or articulating, discharge of mucus from the mouth and nostrils, severe sneezing, swelling of the face, and protrusion of the eyes. Ammonia was of no use; but singular relief was obtained from the inhalation of a little sulphuretted-hydrogen, so that in an hour and a half he was tolerably well †.

Although this gas is obviously very irritating to an unaccustomed person, yet by the force of habit one may breathe without injury an atmosphere much loaded with it. I have been told by a chemical manufacturer at Belfast, that his workmen can work with impunity in an atmosphere of chlorine, where he himself could not remain above a few minutes. The chief consequences of habitual exposure are acidity and other stomach complaints, which the men generally correct by taking chalk. He has likewise observed that they never become corpulent, and that corpulent men who become workmen are soon reduced to an ordinary size. It is not probable, however, that the trade is an unhealthy one; for several of this gentleman's workmen have lived to an advanced age; one man, who died not long ago at the age of eighty, had been forty years in the manufactory; and I have seen in Mr Tenant's manufactory at Glasgow a healthy-looking man who had been also about forty years a workman there. It is an interesting fact, that during the epidemic fever which raged over Ireland from 1816 to 1819, the people of the manufactory at Belfast were exempt from it.

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* Zeitschrift für die Staatsarzneikunde, xvii. 383.

† *Wibmer.* Die Wirkung der Arzneimittel und Gifte, ii. 109, from Archiv des Apothekers-Vereins, xviii. 101.

Of Poisoning with Ammonia.—For an account of the effects of *Ammonia*, which, when in the state of gas, acts violently as an irritant on the mouth, windpipe, and lungs, the reader is referred to the chapter on ammonia and its salts in page 224. It appears to form one of the gases disengaged from the soil of necessaries, as will be noticed presently, and excites inflammation in the eyes of workmen who are incautiously exposed to it [*].

Of Poisoning with Hydrochloric Acid Gas.—I have not met with any account of the effects of *Hydrochloric Acid Gas* on man. But no doubt can be entertained that it will likewise act as a violent and pure irritant. It is exceedingly hurtful to vegetable life. In the course of some experiments performed not long ago by *Dr Turner* and myself on the effects of various gases on plants, we found that a tenth of a cubic inch diluted with 20,000 times its volume of air, so as to be quite imperceptible to the nostrils, shrivelled and killed all the leaves of various plants, which were exposed to it for twenty-four hours [†]. These experiments have been repeated by *Messrs Rogerson*, apparently in ignorance of them. Their results are on the whole the same; and the slight effect obtained by them from very minute proportions of the gas was evidently owing to the small size of their glass-jars not allowing them to use a sufficient quantity of it [‡]. They farther found that proportions of muriatic acid gas amounting to a twentieth of the air kill small animals in half an hour with symptoms of obstructed respiration. Their experiments with less proportions are not precise, yet warrant the inference that even a thousandth part of muriatic acid gas will probably prove fatal in no long time [§].

Of Poisoning with Sulphuretted-Hydrogen Gas.—The *Narcotic*

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[*] *Hallé*, Recherches sur la nature du Méphitisme des fosses d'aisance, p. 107.

[†] Edin. Med. and Surg. Journal, xxviii. 361.

[‡] London Medical Gazette, x. 314.

[§] *Ibidem*, 352

gases are of much greater importance than the irritants, on account of the singularity of their effects, and the greater frequency of accidents with them. This groupe includes sulphuretted-hydrogen, carburetted-hydrogen, carbonic acid, carbonic oxide, nitrous oxide, cyanogen, and oxygen.

Sulphuretted-hydrogen is the most deleterious of all the gases. According to *MM. Thenard* and *Dupuytren*, air impregnated with a 1500th part of the gas kills birds in a short space of time; and with about twice that proportion, or an 800th it will soon kill a dog*. Some time before their researches, *Professor Chaussier* made experiments with it on animals; and he remarked, that in moderate quantity it proved quickly fatal, whether it was inhaled or injected into the cellular tissue, stomach, or anus, or simply applied to the skin. Nine quarts of the gas injected into the anus of a horse killed it in one minute; and a rabbit, whose skin only was exposed to it, died in ten minutes †. *Dr Turner* and I likewise found that it was very injurious to vegetables, and that it acted differently from muriatic acid gas, as it appeared to exhaust the vitality of plants and to cause in them a state analogous to narcotic poisoning in animals. Four cubic inches and a half diluted with eighty volumes of air, caused drooping of the leaves of a mignonette plant in twenty-four hours, and the plant, though then removed into the open air, continued to droop till it bent over altogether and died ‡.

The best account of its effects on man is contained in *M. Hallé's* work §, giving an account of the nature and effects of the exhalations from the pits of the Parisian necessaries, which exhalations appear, from the experiments of Thenard and Dupuytren, to be mixtures chiefly of ammonia and sulphuretted-hydrogen. The symptoms, in cases where the vapours are breathed in a state of concentration, are sudden weakness and all the signs of ordinary asphyxia. The individual becomes suddenly weak and insensible; falls down; and either expires immediately, or, if he is fortunate enough to be quickly extricated, he may revive in no long time, the belly remaining tense and full for an hour or upwards, and recovery being preceded by vomiting and hawking of bloody froth *. When the noxious emanations are less concentrated, several affections have been noticed, which may be reduced to two varieties, the one consisting of pure coma, the other of coma and tetanic convulsions. In the comatose form, the workman seems to fall gently asleep while at work, is roused with difficulty, and has no recollection afterwards of what passed before the accident. The convulsive form is sometimes preceded by noisy and restless delirium, sometimes by sudden faintness, heaving or pain in the stomach, and pains in the arms, and almost always by difficult breathing, from weakness in the muscles of the chest. Insensibility, and a state resembling asphyxia rapidly succeed, during which the pupil is fixed and dilated, the mouth filled with white or bloody froth, the skin cold, and the pulse feeble and irregular. At last convulsive efforts to breathe ensue; these are followed by general tetanic spasms of the trunk and extremities; and if the case is to prove fatal, which it may not do for two hours, a state of calm and total insensibility precedes death for a short interval †. When the exposure has been too slight to cause serious mischief, the individual is affected with sickness, colic, imperfectly defined pains in the chest, and lethargy ‡.

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* *Orfila*, Toxic. Générale, ii. 479.

† Expériences sur les animaux avec le gas hydrogéne sulfuré.—*Sedillot's* Journal de Méd. xv. 28, 34.

‡ Edin. Med. and Surg. Journal, xxviii. 361.

§ Recherches sur la nature du Méphitisme des fosses d'aisance, 1785.

The appearances in the bodies of persons killed by these emanations are fluidity and blackness of the blood, a dark tint of all the internal vascular organs, annihilation of the contractility of the muscles, more or less redness of the bronchial tubes, and secretion of brown mucus there as well as in the nostrils, gorging of the lungs, an odour throughout the whole viscera like that of decayed fish, and a tendency to early putrefaction §. *Chaussier* in his experiments also remarked in animals, that when a plate of silver or bit of white lead was thrust under the skin it was blackened ||.

These extraordinary accidents may be occasioned not only by exposure to the vapours from the *fosses*, but likewise by the incautious inhalation of the vapours proceeding from the bodies

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* Recherches, &c. p. 55.

† Ibidem, pp. 57, 99, 144; and Nouv. Journ. de Méd. i. 237.

‡ Nouv. Journal, &c.

§ Ibidem,

|| *Sedillot's* Journ. de Méd. xv. 25.

of persons who have been asphyxiated there. Sickness, colic, and pains in the chest, are often caused in the latter mode; and *Hallé* has even given an instance of the most violent form of the convulsive affection having originated in the same manner *.

In order that the reader may comprehend the exact cause of these accidents, as it is not easy for an Englishman to comprehend how a person may be suffocated by the fumes of a privy, it is necessary to explain, that in Paris the pipe of the privy terminates under ground, in a pit, which is usually contained in a small covered vault, or is at the bottom of a small square tower open at the roof of the house; and that the pit is often several feet long, wide and deep. Here the filth is sometimes allowed to accumulate for a great length of time, till the pit is full; and it is in the process of clearing it out that the workmen are liable to suffer. *M. Hallé* has given an interesting narrative of an attempt made to empty one of these pits in presence of the Duc de Rochefoucault, the Abbé Tessier, himself, and other members of the Academy of Sciences, who were appointed by the French government to examine into the merits of a pretended discovery for destroying the noxious vapours. The pit chosen was ten feet and a half long, six wide, and at least seven deep; and repeated attempts had been previously made without success to empty it. For some time the process went on prosperously; when at last one of the workmen dropped his bucket into the pit. A ladder being procured, he immediately proceeded to descend, and would not wait to be tied with ropes. "But hardly," says Hallé, "had he descended a few steps of the ladder when he tumbled down without a cry, and was overwhelmed in the ordure below without making the slightest effort to save himself. It was at first thought he had slipped his foot, and another workman promptly offered to descend for him. This man was secured with ropes in case of accident. But scarcely had he descended far enough to have his whole person in the pit except his head, when he uttered a suppressed cry, made a violent effort with his chest, slipped from the ladder, and ceased to move or breathe. His head hung down on his breast, the pulse was gone; and this complete state of asphyxia was the affair of a moment. Another workman descended with the same precautions, fainted away in like manner, but was so promptly withdrawn that the asphyxia was not complete, and he soon revived. At last a stout young man, secured in the same way as the rest, also went down a few steps. Finding himself seized like his companions, he re-ascended to recover himself for a moment; and still not discouraged, he resolved to go down again, and descended backwards, keeping his face uppermost, so that he was able to search for his companion with a hook and withdraw the body." It was impossible to go on with the operation of clearing out; and the pit was shut up again. The first workman never showed any sign of life; the second recovered after discharging much bloody froth; all the persons in the vault were more or less affected; and a gentleman who, in trying to resuscitate the dead workman, incautiously breathed the exhalations from his mouth, was immediately and violently seized with the convulsive form of the affection *.

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* Recherches, &c. p. 57.

Analogous accidents have happened in this country in the clearing out of drains. The presence of sulphurretted-hydrogen in all such noxious emanations is best proved by exposing to them a bit of filtering paper moistened with a solution of lead. The smell alone must not be relied on, as putrescent animal matter exhales an odour like that of sulphuretted-hydrogen, though none be present. Workmen ought to be aware that sulphuretted-hydrogen may be quickly fatal where lights burn with undiminished brilliancy; and that in places where it is apt to accumulate, the degree of purity of the air may vary so much in the course of working, as to be wholesome only a few minutes before, as well as a few minutes after, a fatal accident †.

In the present place, some notice may be taken of an extraordinary accident, which happened lately near London. Great doubts may be entertained whether sulphuretted-hydrogen was the cause of it; and while these exist it is not possible to arrange it under a proper head. It is too important, however, in relation to Medical Jurisprudence, to be omitted in this work; and I take the opportunity of mentioning it here, as the

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* Hallé, Recherches, &c. p. 50. † Ibidem, pp. 46, 53.

accident was ascribed to sulphuretted-hydrogen by those who witnessed it.

In August 1831, twenty-two boys living at a boarding-school at Clapham were seized in the course of three or four hours with alarming symptoms of violent irritation in the stomach and bowels, subsultus of the muscles of the arms, and excessive prostration of strength. Another had been similarly attacked three days before. This child died in twenty-five, and one of the others in twenty-three hours. On examination after death, the Peyerian glands of the intestines were found in the former case enlarged, and as it were tuberculated; in the other there were also ulcers of the mucous coat of the small intestines and softening of that coat in the colon. A suspicion of accidental poisoning having naturally arisen, the various utensils and articles of food used by the family were examined, but without success. And the only circumstance which appeared to explain the accident was, that two days before the first child took ill, a foul cess-pool had been opened, and the materials diffused over a garden adjoining to the children's play-ground. This was considered a sufficient cause of the disease by *Dr Spurgin* and *Messrs Angus* and *Saunders* of Clapham, as well as by *Drs Latham* and *Chambers* and *Mr Pearson* of London, who personally examined the whole particulars [*]. Their explanation may be the only rational account that can be given of the matter; but as no detail of their chemical inquiries has ever been published, their opinion cannot be received with confidence by the medical jurist and the physician, since it is not supported, so far as I am aware, by any previous account of the effects of sulphuretted hydrogen.

Of Poisoning with Carburetted Hydrogen.—Of the several species of carburetted hydrogen gas it is probable that all are more or less narcotic; but they are much inferior in energy to sulphuretted hydrogen.

Sir H. Davy found, that when he breathed a mixture of two parts of air and three of carburetted hydrogen, procured from the decomposition of water by red hot charcoal, he was attacked with giddiness, headach, and transient weakness of the limbs. When he breathed it pure, the first inspiration caused a sense of numbness in the muscles of the chest; the second caused an overpowering sense of oppression in the breast, and insensibility to external objects; during the third he seemed sinking into annihilation, and the mouth-piece dropped out of his hand. On becoming again sensible, which happened in less than a minute, he continued for some time to suffer from a feeling of impending suffocation, extreme exhaustion, and great feebleness of the pulse. Throughout the rest of the day he was affected with weakness, giddiness and rending headach *. These experiments show that the gas is deleterious. Yet *Nysten* found it inert when injected into the veins; and, what is more to the point, colliers breathe the air of coal mines without apparent injury when strongly impregnated with it.

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[*] London Medical Gazette, pp. 375, 410, 448.

The mixed gases of coal-gas or oil-gas appear likewise to be inert when considerably diluted; for gas-men breathe with impunity an atmosphere considerably loaded with them; and in the course of some researches on the illuminating power and best mode of burning these gases, Dr Turner and myself daily breathed air strongly impregnated with them, but never remarked any unpleasant effect whatever. It would seem, however, from a late accident at Paris, that when the impregnation is carried a certain length, poisonous effects may ensue; and that the symptoms then induced are purely narcotic. In consequence of a leak in the service-pipe which supplied a warehouse five individuals who slept in the house were attacked during the night with stupor; and if one of them had not been awakened by the smell and alarmed the rest, it is probable that all would have perished. As it was, one man was found completely comatose and occasionally convulsed, with froth issuing fron the mouth, occasional vomiting, stertorous respiration, and dilated pupils. Some temporary amendment was procured by blood-letting; but the breathing continued laborious, and he expired about nine hours after the party went to bed, and six hours after the alarm was given. On dissection the vessels of the brain were found much gorged, the blood in the heart and great vessels firmly coagulated, one of the lungs congested and its bronchial tube blocked up by a kidney-bean. The cause of death in this case is therefore doubtful †.—In regard to all the carburetted hydrogen gases it is obvious, that their effects are greatly impaired by moderate dilution with air.

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* Researches on Nitrous Oxide Gas, p. 467.

† Annales d'Hyg. Publ. et de Méd. Lég. iii. 457.

Of Poisoning with Carbonic Acid Gas.—Carbonic acid gas is by far the most important of the deleterious gases; for it is the daily source of fatal accidents. It is extricated in great quantity from burning fuel: it is given out abundantly in the calcining of lime; it is disengaged in a state of considerable purity in brew-houses by the fermentation of beer; it is often met with in mines and caverns, particularly in coal-pits and draw-wells; it may collect in apartments where fuel is burnt without a proper outlet for the vitiated air, or where persons are crowded too much for the capacity of the room. Hence many have been killed by descending incautiously into draw-wells, by falling into beer-vats, and by sleeping before the traps of lime-kilns, or in apartments without vents and heated by choffers. Instances have even occurred of the same accident from sleeping in green-houses during the night, when it is well known that plants exhale much carbonic acid; and some dreadful cases have occurred of suffocation from confinement in small crowded rooms.

Physiologists, as already remarked, are not quite agreed as to the action of carbonic acid gas,—whether it is a positive poison, or simply an asphyxiating gas. But in my opinion reasons enough exist for believing that it is positively and energetically poisonous. This is perhaps shown by its effects being much more rapidly produced, and much more slowly and imperfectly removed than asphyxia from immersion in hydrogen or azote [*]. Thus immersion for twenty-five seconds in an atmosphere of carbonic acid gas has been found sufficient to kill an animal outright; and fifteen seconds will kill a small bird [†]. But it is more unequivocally established by the three following facts:

In the first place, if, instead of the nitrogen gas contained in atmospheric air, carbonic acid gas be mixed with oxygen in the same proportion, animals cannot breathe this atmosphere for two minutes without being seized with symptoms of poisoning [‡]. Even a much less proportion has the same effect. Nay, persons have become apoplectic in an atmosphere of carbonic acid gas which to those who entered it appeared at first quite respirable [*].

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[*] *M. Collard de Martigny* in Arch. Gén. de Méd. xiv. 209.

[†] Journal der Praktischen Heilkunde, 1831, iv. 119.

[‡] *Collard de Martigny*, 204.

Secondly, *Professor Rolando* of Turin having found that the land tortoise sustained very little injury when the great air-tube of one lung was tied,—he contrived to make it breathe carbonic acid gas with one lung, while atmospheric air was inhaled by the other; and he remarked that death took place in a few hours [†].

Thirdly, the symptoms caused by inhaling the gas may be also produced by its application to the inner membrane of the stomach or to the skin. On the other hand, aërated water has been known to cause giddiness or even intoxication when drunk too freely at first [‡]; and the sparkling wines probably owe their rapid power of intoxicating to the carbonic acid they contain. And, on the other hand, *M. Collard de Martigny* has found that, if the human body be inclosed in an atmosphere of the gas, due precautions being taken to preserve the free access of common air to the lungs, the usual symptoms of poisoning with carbonic acid are produced, such as weight in the head, obscurity of sight, pain in the temples, ringing in the ears, giddiness, and an undefinable feeling of terror; and that if the same experiment be made on animals and continued long enough, death will be the consequence.

When a man attempts to inhale pure carbonic acid gas, for example by putting the face over the edge of a beer-vat, or the nose into a jar containing chalk and muriatic acid, the nostrils and throat are irritated so strongly, that the glottis closes and inspiration becomes impossible. *Sir H. Davy* in making this experiment farther remarked, that the gas causes an acid taste in the mouth and throat, and a sense of burning in the uvula [‖]. I have remarked the same effects from very pure gas disengaged by tartaric acid from carbonate of soda. Hence when a person is immersed in the gas nearly or perfectly pure, as in a beer-vat, or old well, he dies at once of suffocation.

The effects are very different when the gas is considerably diluted; for the symptoms then resemble apoplexy. As they differ somewhat according to the source from which the gas is derived, and the admixtures consequently breathed along with it, it will be necessary to relate an example of the effects of the pure gas diluted with air,—of the emanations from burning charcoal, tallow, and coal,—and finally of air vitiated by the breath.

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[*] Nouv. Biblioth. Méd. 1827, iii. 91.

[†] Archives Gén. de Méd. v. 132.

[‡] *Foderé*, Méd. Légale, iv. 37.

[§] Archives, &c. p. 211.

[‖] Recherches on Nitrous Oxide, p. 472.

1. *M. Chomel* of Paris has related a case of poisoning with the gas diluted with air, occurring in the person of a labourer, who was suddenly immersed in it at the bottom of a well, and remained there three quarters of an hour. He was first affected with violent and irregular convulsions of the whole body and perfect insensibility, afterwards with fits of spasm like tetanus; and during the second day, when these symptoms had gone off, he continued to be affected with dumbness *.—It is worthy of particular remark that, contrary to general belief, these effects may be produced in situations where the air is not sufficiently impure to extinguish lights. Thus *M. Collard de Martigny* relates the case of a servant, who, on entering a cellar where grape-juice was fermenting, became suddenly giddy, and, under a vague impression of terror, fled from the place, dropping her candle on the floor and shutting the door behind her. She fell down insensible outside the door, and those who went to her assistance found on opening the door that the light continued to burn †.—It is also important to observe, that, contrary to what would be expected from the statements of Sir H. Davy and other experimentalists on the effects of the pure gas, it will often happen that no odour or taste is perceived. *M. Bonami*, in an account of an accident which happened at Nantes to two workmen who descended an old well, says that the first while descending uttered a piercing cry and fell down; and that as soon as his comrade, who tried to rescue him, was lowered ten or twelve feet, he felt as if he was about to be suffocated for want of breath, but perceived no strong or disagreeable smell ‡. It should be remembered therefore by workmen, that there may be danger in descending pits where none is indicated by the sense of smell, or by the extinguishing of a light.

2. The fumes of Burning Charcoal have been long known

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* Nouv. Journal de Méd. ii. 196.

† Archives Gén. de Médecine, xiv. 205.

‡ Histoire de la Soc. Roy. de Méd. i. 353.

to be deleterious. The early symptoms caused by them have been seldom noticed, because this variety of poisoning being generally accidental, and occurring during sleep, the patient is seldom seen till the symptoms are fully formed. From the history of the attempt at self-destruction alluded to at the commencement of this chapter, it appears that the first effects are slight oppression, then violent palpitation, and next confusion of ideas, gradually ending in insensibility [*]. Tightness in the temples and an undefinable sense of alarm have also been remarked as the incipient symptoms [†]; but others have, on the contrary, experienced a pleasing sensation that seduced them to remain on the fatal spot [‡].

The following abstract of a case by *Dr Babington* will convey an accurate idea of the advanced symptoms. The waiter of a tavern and a little boy, on going to bed, left a choffer of charcoal burning beside it; and next morning were found insensible. The boy died immediately after they were discovered. The waiter had stertorous breathing, livid lips, flushing of the face, and a full, strong pulse; for which affections he was bled to ten ounces. When Dr Babington first saw him, however, the pulse had become feeble, the breathing imperfect, and the limbs cold; the muscles were powerless and twitched with slight convulsions, the sensibility gone, the face pale, the eyelids closed, the eyes prominent and rolling, the tongue swollen and the jaw locked upon it, and there was a great flow of saliva from the mouth. The employment of galvanism at this time caused an evident amendment in every symptom. But it was soon abandoned; because each time it was applied, the excitement was rapidly followed by a corresponding depression. Cold water was then dashed upon him, ammonia rubbed on his chest, oxygen thrown into the lungs, and through these and other means a warm perspiration was brought out, and his state rapidly improved. He was nearly lost, however, during the subsequent night by hemorrhage from the divided vein; but next day he was so well, that he could even speak a little. For two days afterwards the left side of the face was paralyzed, and his mental faculties were somewhat disordered [§].—In such cases as this the stupor is generally very deep. There is a case in a French Journal of a girl, who, after remaining some time in a small close chamber heated by a charcoal choffer, fell down insensible, remained in that state for three hours, and when she recovered from her lethargy, found that the choffer had fallen, and burnt the skin and subjacent fat of the thighs to a cinder [*].

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[*] Nouv. Biblioth. Méd. 1827, iii. 91.

[†] *Collard de Martigny*, Arch. Gén. de Méd. xiv. 205.

[‡] *Orfila*, Toxicol. Gén. ii. 475. Note.

[§] Lond. Med. Chir. Trans. i. 83.

Occasionally the stage of stupor is followed, as in some other varieties of narcotic poisoning, by a stage of delirium, at times of the furious kind, or by a state resembling somnambulism [†]. It does not follow that recovery is certain because coma has thus given place to delirium,—an alteration, which in most varieties of narcotic poisoning is considered a sure sign of recovery. *Collard de Martigny* has related a case which eventually proved fatal, notwithstanding this sign of amelioration [‡].

The narcotism induced by breathing charcoal fumes often lasts a considerable length of time,—much longer indeed than the effects of other narcotic poisons. This will appear sufficiently from the case described by Dr Babington. One of the people mentioned at the commencement of this chapter as having been suffocated at Gerolzhofen lingered five days in a state of coma before he expired.

Commonly in cases of recovery, there is found to have been no consciousness of any thing going on around, or recollection of what passed subsequently to the first impressions mentioned above. But a singular instance of the contrary has been published, where the individual, though apparently insensible, knew when the room was first entered by strangers, and heard them call him by name and bid him put out his tongue, and stretch forth his arm,—without, however, his having the power to answer or in any way to express the consciousness of understanding them [§].

According to the researches of *Orfila*, the emanations from burning charcoal when in a state of vivid ignition consist of carbonic acid gas as the only foreign ingredient. A hundred parts of the air evolved are composed of 42 azote, 46 common air, and 12 carbonic acid. But when the charcoal burns faintly, a hundred parts contain 52 of azote, 20 of common air, 14 of carbonic acid, and 14 of carburetted-hydrogen *. It appears that the vapours are most dangerous in the latter state; for in countries where charcoal choffers are much used for warming close chambers it is found unsafe to close up the doors till the fuel is in a state of vivid ignition. The experiments of Orfila show that a much larger proportion of the oxygen of the air passes through unconsumed than when combustion is dull. In truth, it often happens on this account that the proportion of carbonic acid in a poisonous atmosphere is very small. In the case of attempt at suicide the proportion was so small that the people who entered the apartment found the air quite respirable, and the choffer burning, although the person they sought was in a state of deep coma. It has also been already remarked, that coma is rapidly induced where the air is pure enough to support the combustion of lights. An observation worthy of note, as at times supplying the only rational explanation of the discrepant effects of the poison on several individuals simultaneously and to appearance alike exposed to it, is that in a close apartment the gas abounds most in the lowest part by reason of its high density; but that where a current from without is directed through the room, as for example from below a door towards a fire or stove, the situation where least effect is produced may be exactly that which in other circumstances is the most dangerous, namely on the floor.

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[*] Nouv. Journ. de Méd.

[†] Nouv. Biblioth. Méd. 1827, iii. 91.

[‡] Archives Gén. de Méd. xiv. 210.

[§] *Fallot*, in Journal Complémentaire. Mai 1829.

3. It is probable that in some circumstances a very small quantity of the mixed gases proceeding from the slow combustion of tallow and other oily substances will produce dangerous symptoms. *Dr Blackadder* remarked in the course of his experiments on flame, that the vapour into which oil is resolved, previous to its forming flame round the wick, excites in minute quantities intense headach †. The emanations from the burning snuff of a candle are probably of the same nature and are very poisonous. An instance indeed has been recorded in which they proved fatal. A party of iron-smiths, who were carousing on a festival day at Leipzig, amused themselves with plaguing a boy, who was asleep in a corner of the room, by holding un-

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* Toxicol. Gén. ii. 474.

† On the Constitution of Flame—Edin. New Philos. Journal, i. 224, 226.

der his nose the smoke of a candle just extinguished. At first he was roused a little each time. But when the amusement had been continued for half an hour he began to breathe laboriously, was then attacked with incessant epileptic convulsions, and died on the third day [*].—The effects of such emanations are probably owing to empyreumatic volatile oil, which will be presently seen to be an active poison.

4. The vapours from burning coal are the most noxious of all kinds of emanations from fuel, and cause peculiar symptoms. But they are less apt to lead to accidents than the vapour of charcoal, as they are much more irritating to the lungs. This effect depends on the sulphurous acid gas which is mingled with the carbonic acid.

Sulphurous acid gas is exceedingly deleterious to vegetable life, being hardly inferior in that respect to muriatic acid. *Dr Turner* and I found that a fifth of a cubic inch diluted with ten thousand times its volume of air destroyed all the leaves of various plants in forty-eight hours [†]. I am not acquainted with any experiments on animals or observations on man regarding the effects of the pure gas. But it will without a doubt prove a powerful irritant.

Some of the peculiarities in the cases now to be mentioned were possibly owing to the admixture of sulphurous acid gas with the carbonic, both being inhaled in a diluted state. The cases are described by *Mr Braid*, lately surgeon at Leadhills. In March 1817 several of the miners there were violently affected, and some killed, in consequence, it was supposed, of the smoke of one of the steam engines having escaped into the waygates, and contaminated the air in the workings. Four men who attempted to force their way through this air into the workings below were unable to advance beyond, and seem to have died immediately. The rest attempted to descend two hours after, but were suddenly stopped by the contaminated air. As soon as they reached it, although their lights burnt tolerably well, they felt difficulty in breathing, and were then seized with violent pain and beating in the head, giddiness and ringing in the ears, followed by vomiting, palpitation and anxiety, weakness of the limbs and pains above the knees, and finally with loss of recollection. Some of them made their escape, but others remained till the air was so far purified that their companions could descend to their aid. When Mr Braid first saw them, some were running about frantic and furious, and striking all who came in their way,—some ran off terrified whenever any one approached them,—some were singing,—some praying,—and others lay listless and insensible. Many of them retched and vomited. In some the pulse was quick, in others slow, in many irregular, and in all feeble. All who could describe their complaints had violent headach, some of them tenesmus, and a few diarrhœa. In a few days all recovered except the first four and three others who had descended to the deeper parts of the mine [*].—Another accident of the same nature, and followed by the same phenomena, happened more lately at Leadhills [†]. Similar accidents have been also witnessed by *Mr Bald*, civil-engineer, among the coal-miners who work in the neighbourhood of a burning mine belonging to the Devon Company. It is worthy of remark, that the men sometimes worked for a considerable length of time before they were taken ill. Such being the case, it will be readily conceived that the burning of the lights was not a test of the wholesomeness of the air. Here, as at Leadhills and in other instances already mentioned, the lights continued to burn where the men were poisoned [‡].

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[*] *Ammann*,—Medicina Critica, Cas. 59, p. 365.

[†] Edin. Med and Surg. Journal, xxviii. 359.

5. Somewhat analogous to the symptoms now described are the effects of the gradual contamination of air in a confined apartment. Every one must have read of the horrible death of the Englishmen who were locked up all night in a close dungeon in Fort William at Calcutta. One hundred and forty-six individuals were imprisoned in a room twenty feet square, with only one small window; and before next morning all but 23 died under the most dreadful of tortures,—that of slowly increasing suffocation. They seem to have been affected nearly in the same way as the workmen at Leadhills [§]. A similar accident happened in London in 1742. The keeper of the Round-house of St Martin's, crammed 28 people into an apart-

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[*] Edin. Med. and Surg. Journal, xiii. 353.

[†] Ibidem, xxxii. 345.

[‡] Edin. New Phil. Journal, v. 110.

[§] *Holwell*, Narrative of the deplorable Deaths of the English gentlemen and others who were suffocated in the Black Hole in Fort William.

ment six feet square and not quite six feet high; and four were suffocated [*].

The morbid appearances left in the body after poisoning with carbonic acid gas have been chiefly observed in persons killed by charcoal vapour. According to *Portal* the vessels of the brain are congested, and the ventricles contain serum; the lungs are distended, as if emphysematous; the heart and great veins are gorged with black fluid blood; the eyes are generally glistening and prominent, the face red, and the tongue protruded and black [†]. Gorging of the cerebral vessels seems to be very common. Yet sometimes it is inconsiderable, as in two cases related by *Dr Bright*, where, except in the sinuses and in the greater veins of the ventricles and substance of the brain, no particular gorging or vascularity seems to have been met with,—the external membranes in particular having been very little injected [‡]. This, however, is certainly a rare occurrence. *Dr Schenck*, medical inspector of Siegen, in reporting two cases of death caused by the vapours of burning wood, notices paleness of the countenance as a singular accompaniment of cerebral congestion; and calls the attention of medical jurists to the extreme calmness of the features as a general character of this variety of poisoning [§]. The countenance is always composed, but generally livid. It appears from an account in *Pyl's* Essays of several cases of suffocation from the fumes of burning wood, that, besides the appearances mentioned by Portal, there is usually great livor of the back, frothiness as well as fluidity of the blood, and more or less gorging of the lungs with blood and foam [‖]. A common appearance where the poisonous emanation has been charcoal vapour, is a lining of dark, or sometimes actually black dust on the mucous membranes of the air-passages, thickest near the external opening of the nostrils, and disappearing towards the glottis. There are obvious reasons why this appearance cannot always be expected to occur; but when present, it may be in doubtful circumstances a very important article of evidence [¶]. In *Wild-*

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[*] *Smith's* Principles of Forensic Medicine, 221.

[†] Instruction sur le traitement des Asphyxiés, 25.

[‡] Reports of Medical Cases, ii. 226, 227.

[§] Horn's Archiv für Medizinische Erfahrung, 1823, i. 93.

[‖] Aufsätze und Beobachtungen, i. 1. and vii. 95.

[¶] See various cases quoted in detail in *Wibmer*, die Wirkung der Arzneimittel, &c. ii. 49, 51, 55.

berg's collection of cases there is a report on two people who were suffocated in bed, in consequence of the servant having neglected to open the flue-trap when she kindled the stove in the bed-chamber; and in each of them Wildberg found all the appearances now quoted from Portal and Pyl. The tongue was black and swelled [*]. *Mertzdorff* has related a case of death from the same cause, in which, together with the preceding appearances, an effusion of blood was found between the arachnoid and pia mater over the whole surface of both hemispheres [†]. In one of *Dr Bright's* cases there was a small ecchymosis in the cortical substance on the outer side of the anterior lobe, and not extending into the medullary matter. *Fallot* mentions an instance of suffocation from charcoal vapour, where a little coagulated blood was found between the layers of the arachnoid membrane of the cerebellum in the region of the left occipital hollow [‡]. Such appearances might be expected more frequently, considering the manifest tendency of this kind of poisoning to cause congestion in the head. In a case mentioned by *M. Rayer* globules of an oily-looking matter were found swimming on the surface of the blood and urine [§]. But this is a solitary observation. The body usually remains flaccid, and the customary stage of rigidity is imperfect. In some instances, however, as in those related by Dr Schenck, the stage of rigidity is passed through in the usual manner. It is not uncommon to find vomited matter lying beside the body, a circumstance which may naturally mislead the unpractised. This is represented by *Professor Wagner* of Berlin to have occurred uniformly in his experience [‖]; and it is also mentioned in many of the cases reported by others; but it is not invariable. A red appearance in the stomach and intestines has been noticed in many cases [¶], and often ascribed to inflammation; but it is probably nothing more than the result of the venous congestion, which pervades most of the membranous surfaces of the body.

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[*] Practisches Handbuch für Physiker, iii. 278.

[†] Beiträge zur gerichtl. medizin.—*Horn's* Archiv für Medizinische Erfahrung, 1823, i. 296.

[‡] Journal Complémentaire, Mai 1829.

[§] Revue Médicale, 1827, iii. 528.

[‖] *Horn's* Archiv für Medizinische Erfahrung, 1834, 746.

[¶] *Wibmer*, die Wirkung der Arzneimittel, &c. ii. 47, *et seq.*

The treatment of poisoning with carbonic acid consists chiefly in the occasional employment of the cold affusion and in moderate blood-letting either from the arm or from the head. In a case which happened at Paris, where a lady tried to make away with herself by breathing charcoal fumes, and was found in a state of almost hopeless insensibility, various remedies were tried unsuccessfully, till cupping from the nape of the neck was resorted to; and she then rapidly recovered *.—A recent instance where blood-letting was also singularly successful deserves particular mention, because for three hours the patient remained without pulsation in any artery and without the slightest perceptible respiration. At first neither by cupping nor by venesection could any blood be obtained; and it was only after the long interval just mentioned and the constant artificial inflation of the lungs, that the blood at length trickled slowly from the arm. The pulse and breathing were after this soon re-established; but it was not till eight hours later that sensibility returned †.

Of Poisoning with Carbonic Oxide Gas.—Carbonic oxide gas, according to Nysten, has not any effect on man when injected into the pleura; but when thrown slowly into the veins, it gives the arterial blood a brownish tint, and induces for a short time a state resembling intoxication ‡. The quantity injected into the veins was probably too small to produce the full effect, or it was discharged in passing through the lungs; for this gas certainly appears to be very deleterious when breathed by man.

A set of interesting but hazardous experiments were made with it not long ago by the assistants of *Mr Higgins* of Dublin. One gentleman, after inhaling it two or three times, was seized with giddiness, tremors, and an approach to insensibility, succeeded by languor, weakness, and headach of some hours' duration. The other had almost paid dearly for his curiosity. Having previously exhausted his lungs, he inhaled the pure gas three or four times, upon which he was suddenly deprived of sense and motion, fell down supine, and continued for half an hour insensible, apparently lifeless, and with the pulse nearly extinct. Various means were tried for rousing him, without success; till at last oxygen gas was blown into the lungs. Animation then returned rapidly: But he was affected for the rest of the day with convulsive agitation of the body, stupor, violent headach, and quick irregular pulse; and after his senses were quite restored, he suffered from giddiness, blindness, nausea, alternate heats and chills, succeeded by feverish, broken, but irresistible sleep [*].

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* Nouvelle Bibliothèque Méd. 1829, i. 374.

† *Réné-Bourgeois*, Archives Gén. de Méd. xx. 508.

‡ Nysten, Recherches Chimico-Physiologiques, pp. 88, 92, 96.

Of Poisoning with Nitrous Oxide Gas.—The Nitrous Oxide or Intoxicating Gas is the last of the Narcotic gases to be noticed. Nysten found, that, when slowly injected in large quantities into the veins of animals, it only caused slight staggering [†]. Frequent observation, however, has shown that it is by no means so inert when breathed by man. *Sir H. Davy*, who first had the courage to inhale it, observed that it excited giddiness, a delightful sense of thrilling in the chest and limbs, acuteness of hearing, brilliancy of all surrounding objects, and an unconquerable propensity to brisk muscular exertion. These feelings were of short duration, but were generally succeeded by alertness of body and mind, never by the exhaustion, depression and nausea, which follow the stage of excitement brought on by spirits or opium [‡]. Although many have since experienced the same enticing effects, yet they are by no means uniform. For others have been suddenly seized with great weakness, tendency to faint, loss of voice, and sometimes convulsions; and two of Thenard's assistants, on making the experiment, fainted away, and remained some seconds motionless and insensible [§]. It is a remarkable circumstance in the operation of this gas, that, unlike other stimulants, it does not lose its virtues under the influence of habit. Neither does the habitual use of it lead to any ill consequence. *Sir H. Davy* in the course of his researches, which were continued above two months, breathed it occasionally three or four times a-day for a week together, at other periods four or five times a-week only; yet at the end his health was good, his mind clear, his digestion perfect, and his strength only a little impaired [*].

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[*] Edin. Philos. Journal.

[†] Nysten, Recherches, &c.

[‡] Davy's Chemical and Philosophical Researches, *passim*.

[§] *Thenard*, Traité de Chimie, iii. 675.

Nitrous oxide gas is one of the few gases that are not injurious to vegetables. *Dr Turner* and I found that seventy-two cubic inches diluted with six times their volume of air had no effect on a mignonette plant in forty-eight hours [†].

Of Poisoning with Cyanogen Gas.—*Cyanogen Gas* has been proved by the experiments of *M. Coullon* to be an active poison to all animals,—the guinea-pig, sparrow, leech, frog, wood-louse, fly, crab; and the symptoms induced were coma, and more rarely convulsions [‡]. These results are confirmed by the later experiments of *Hünefeld*, who found that it produces in the rabbit anxious breathing, slight convulsions, staring of the eyes, dilated pupils, coma, and death in five or six minutes [§]. *Buchner* likewise found that small birds held for a few seconds over the mouth of a jar containing cyanogen died very speedily; and on one occasion remarked, while preparing the gas, that the fore-finger which was exposed to the bubbles as they escaped became suddenly benumbed, and that this effect was attended with a singular feeling of pressure and contraction in the joints of the thumb and elbow [||]. It would undoubtedly be most dangerous to breathe this gas except much diluted and in very small quantity.

Of all the narcotic gases it is the most noxious to vegetables. Dr Turner and I found that a third of a cubic inch, diluted with 1700 times its volume of air, caused the leaves of a mignonette plant to droop in twenty-four hours. As usual with the effects of narcotic gases on vegetables, the drooping went on after the plant was removed into the open air; and in a short time it was completely killed [¶].

Of Poisoning with Oxygen Gas.—Of all the narcotic gases none is more singular in its effects than oxygen. When breathed in a state of purity by animals, they live much longer than in the same quantity of atmospheric air. But if the experiment be kept up for a sufficient length of time, symptoms of narcotic poisoning begin to manifest themselves. For an hour no inconvenience seems to be felt; but the breathing and pulse then become accelerated; a state of debility next ensues; at length insensibility gradually comes on, with glazing of the eyes, slow respiration and gasping; coma is in the end completely formed; and death ensues in the course of six, ten, or twelve hours. If the animals are removed into the air before the insensibility is considerable they quickly recover. When the body is examined immediately after death the heart is seen beating strongly, but the diaphragm motionless; the whole blood in the veins as well as the arteries is of a bright scarlet colour; some of the membranous surfaces, such as the pulmonary pleura, have the same tint, and the blood coagulates with remarkable rapidity. The gas in which an animal has died rekindles a blown out taper. These experiments, which physiology owes to the researches of *Mr Broughton* *, furnish a solitary example of death from stoppage of the respiration, while the heart continues to pulsate, and the lungs to transmit florid blood. Death is probably owing to hyper-arterialization of the blood.

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[*] Researches, &c. p. 462.

[†] Edin. Med. and Surg. Journ. xxviii. 363.

[‡] Journal Universel des Sc. Méd. ii. 240.

[§] Archiv für Medizinische Erfahrung, 1830, ii. 859.

[||] Toxikologie, 382.

[¶] Edin. Med. and Surg. Journal, xxviii. 363.

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* London Quarterly Journal of Science, January 1830.

CHAPTER XXXII.

CLASS THIRD.

OF NARCOTICO-ACRID POISONS GENERALLY.

THE Third Class of Poisons, the Narcotico-Acrids, includes those which possess a double action, the one local and irritating like that of the Irritants, the other remote, and consisting of an impression on the nervous system.

Sometimes they cause Narcotism; which is generally of a comatose nature, often attended with delirium; but in one very singular groupe there is neither insensibility nor delirium, but merely violent tetanic spasms.

At other times they excite inflammation where they are applied. This effect, however, is by no means constant. For Orfila justly observes, that under the name of narcotico-acrids several poisons are usually described which seldom excite inflammation. Those which inflame the tissues where they are applied rarely occasion death in this manner. Some of them may produce very violent local symptoms; but they generally prove fatal through their operation on the nervous system.

For the most part, their narcotic and irritant effects appear incompatible. That is, when they act narcotically, the body is insensible to the local irritation; and when they irritate, the dose is not large enough to act narcotically. In large doses, therefore, they act chiefly as narcotics, in small doses as irritants. Sometimes, however, the narcotic symptoms are preceded or followed by the symptoms of irritation; and more rarely both exist simultaneously.

Most, if not all, of them, to whatever part of the body they are applied, act remotely by entering the blood-vessels; but it has not been settled whether they operate by being carried with the blood to the part on which they act, or by producing on the inner membrane of the vessels a peculiar impression, which is conveyed along the nerves. Some of them produce direct and obvious effects where they are applied. Thus monks-hood induces a peculiar numbness and tingling of the part with which it is placed in contact. The organs on which they act remotely are the brain and spine, and sometimes the heart also.

The appearances in the dead body are, for the most part, inconsiderable; more or less inflammation in the stomach or intestines, and congestion in the brain; but even these are not constant.

As a distinct Class, they differ little from some poisons of the previous classes. Several of the metallic irritants, and a few of the vegetable acrids are, properly speaking, narcotico-acrids: They excite either narcotism or irritation, according to circumstances. But still, the poisons about to be considered form a good natural order when contrasted with these irritants. For the irritants which possess a double action are nevertheless characterized by the symptoms of inflammation being at least their most prominent effects; while the most prominent feature in the effects of the poisons now to be considered is injury of the nervous system.—It is more difficult to draw the line of separation between the present class and the pure narcotics; for many of the Narcotico-acrids rarely cause any symptoms but those of Narcotism.

The Narcotico-acrids are all derived from the vegetable kingdom. Many of them owe their power to an alkaloid, consisting of oxygen, hydrogen, carbon, and a little azote.

The characters which distinguish the symptoms and morbid appearances of the narcotico-acrids from those of natural disease, do not require special mention; for almost all the remarks made in the introduction to the class of Narcotics are applicable to the present class also. A few of the characters, however, which have been laid down, do not apply so well to the Narcotico-acrids as to the narcotics. In particular, it appears that what was said on the short duration of the effects of the narcotics does not apply so well to the Narcotico-acrids, some of which given in a single dose continue to cause symptoms even of narcotism for two or three days. But the rule, that they seldom prove fatal if the case lasts above twelve hours, is still applicable,—at all events they rarely prove fatal after that interval by their narcotic action. The poisonous Fungi, however, have proved fatal as narcotics so late as thirty-six hours, or even three days after they were taken; and perhaps Digitalis has proved fatal narcotically at the remote period of three weeks. But such cases are extremely rare.

Some of the Narcotico-acrids, such as the different species of *Strychnos*, are quite peculiar in their effects; so that their symptoms may be distinguished at once from natural disease.

Orfila divides the Narcotico-acrids into six groupes, and this arrangement will be followed in the present work; but they are not all very well distinguished from one another.

CHAPTER XXXIII.

OF POISONING WITH NIGHTSHADE, THORN-APPLE, AND TOBACCO.

THE first groupe of the Narcotico-acrids comprehends the poisons whose principal symptom is delirium. All the plants of the groupe belong to the natural order *Solaneæ*, and Linnæus's class Pentandria Monogynia. Those which have been particularly examined are Deadly Nightshade, Thorn-Apple, and Tobacco.

Of Poisoning with Deadly Nightshade.

The Deadly Nightshade, or *Atropa Belladonna*, is allied in physiological and botanical characters to the *Hyoscyamus* and *Solanum* formerly mentioned; and by the older writers, indeed, was confounded with the latter. It is a native of Britain and grows in shady places, particularly on the edge of woods. The berries, which ripen in September, have a jet-black colour. Their beauty has frequently tempted both children and adults to eat them; and many have suffered severely. But it is not the berry alone which is poisonous; the whole plant is so; but the root is probably the most active part *. From one to four grains of the dried powder of the root will occasion extraordinary dryness in the throat, giddiness, staggering, flushed face, dilated pupils, and sometimes even delirium †. The juice of the leaves is very energetic, two grains of its extract being, when well prepared, a large enough dose to cause disagreeable symptoms in man. It appears, however, to be a very uncertain preparation, unless when procured by evaporation *in vacuo;* for some samples from the Parisian shops have been found by Orfila to be quite inert.

It contains a peculiar alkaloid, named *Atropia.* In the Belladonna, as in Hyoscyamus, *Brandes* obtained a volatile, oily-like, alkaloidal fluid, of a penetrating narcotic smell, and bitterish, acrid taste, slightly soluble in water, and freely soluble in alcohol or ether, capable of neutralizing acids and then rendered more fixed, and existing in the plant in the form of salt, so that it cannot be displaced from the leaves by distillation, unless also disengaged from its natural state of combination by the superior affinity of lime or an alkali [*]. The ulterior researches of *Geiger* and *Hesse*, however, as well as the simultaneous analysis of *Mein*, seem to prove that this fluid is not the pure alkaloid of belladonna, and that the real atropia is a solid substance, forming colourless, silky crystals, soluble in ether and alcohol, sparingly so in water, slightly bitter, liable to decomposition under contact with air and moisture, volatilizable, but with some decomposition, a little above 212°, and forming definite crystallizable salts with acids [†]. The aqueous solutions of its salts exhale during evaporation a narcotic vapour, which dilates the pupil, and causes sickness, giddiness, and headach [‡].

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* *Buchner's* Toxikologie, 188.

† *Wibmer,* Die Wirkung der Arzneimittel, &c. i. 360, 362.

The ordinary extract of belladonna in the dose of half an ounce will kill a dog in thirty hours when introduced into the stomach. Half that quantity applied to a wound will kill it in twenty-four hours. And forty grains injected into the jugular vein prove even more quickly fatal. Convulsions are rarely produced, but only a state like intoxication [§].

The oleaginous atropia of *Brandes* in the dose of two or three drops kills small birds instantaneously like concentrated hydrocyanic acid; in less doses it occasions staggering, gasping, and in a few minutes death amidst convulsions; and the dead body presents throughout the internal organs great venous turgescence and even extravasation of blood, but more especially excessive congestion within the head [||]. The pure crystalline atropia of *Mein*, when dissolved in water and greatly diluted, causes extreme dilatation of the pupils of long continuance.

Symptoms in Man.—On man the effects of belladonna are much more remarkable. In small doses, whatever be the kind of surface to which it is applied,—such as the skin round the eye, or the surface of a wound, or the inner membrane of the stomach,—it causes dilatation of the pupil. This effect may be excited without any constitutional derangement. When the extract is rubbed on the skin round the eye, vision is not impaired; but when it is taken internally so as to affect the pupils, the sight is commonly much obscured. The effects of large or poisonous doses have been frequently witnessed in consequence of children and adults being tempted to eat the berries by their fine colour and bright lustre. From the cases that have been published the leading symptoms appear in the first instance to be dryness in the throat, then delirium with dilated pupils, and afterwards coma. Convulsions are rare, and, when present, slight.

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[*] Annalen der Pharmacie, i. 68.

[†] *Ibidem*, 1833, or Journal de Pharmacie, xx. 87.

[‡] *Buchner's* Repertorium für die Pharmacie, ix. 71 and 77.

[§] *Orfila*, Toxicol. Gén. ii. 261.

[||] Annalen der Pharmacie, i. 71.

The dryness of the throat is not a constant symptom. It is often, however, very distinct. It occurred, for example, in 150 soldiers who were poisoned near Dresden, as related by *M. Gaultier de Claubry* [*], and in six soldiers whose cases have been described by *Mr Brumwell* [†]. The former had not only dryness of the throat but likewise difficulty in swallowing.

The delirium is generally extravagant, and also most commonly of the pleasing kind, sometimes accompanied with immoderate uncontrollable laughter, sometimes with constant talking, but occasionally with complete loss of voice, as in the cases of the 150 soldiers. At other times the state of mind resembles somnambulism, as in the instance of a tailor who was poisoned with a belladonna injection, and who for fifteen hours, though speechless and insensible to external objects, went through all the customary operations of his trade with great vivacity, and moved his lips as if in conversation [‡].

The pupil is not only dilated in all cases, but likewise for the most part insensible [§]; and, as in the soldiers at Dresden, the eyeball is sometimes red and prominent. The vision also, as in these soldiers, is generally obscure; sometimes it is lost for a time [||]; and so completely that even the brightest light cannot be distinguished [¶].

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[*] *Sedillot's* Journ. Gén. de Méd. Dec. 1813, 364.

[†] London Med. Obs and Inquiries, vi. 223.

[‡] Journ. Universel, xxii. 230.

[§] *Sedillot's* Journ. de Méd. xxiv. 228.

[||] Edin. Med. and Surg. Journal. ix. 380.

[¶] Journ. de Chim. Méd. ii. 586.

The sopor or lethargy, which follows the delirium, occasionally does not supervene for a considerable interval. In a case related by *Munnik* it did not begin till twelve hours after the poison was taken [*]. Sometimes, as in the same case, the delirium returns when the stupor goes off; and very frequently the stupor is not distinct at any stage.—Even the delirium is not always formed rapidly. A man whose case is described by *Sir John Hill* did not become giddy for two hours after eating the berries, and the delirium did not appear till five hours later [†]. In Mr Brumwell's cases, the delirium was not particularly noticed till the morning after the berries were taken.

Convulsions, it has been already stated, are rare. In the case from the 24th volume of *Sedillot's* Journal, the muscles of the face were somewhat convulsed: there is also at times more or less locked-jaw [‡], or subsultus tendinum [§]; and occasionally much abrupt agitation of the extremities [‖]. But well-marked convulsions do not appear to be ever present.

The effects now detailed are by no means so quickly dissipated as those of opium. Almost every person who has taken a considerable dose has been ill for a day at least. The case from *Sedillot's* Journal lasted three days, delirium having continued twelve hours, the succeeding stupor for nearly two days, and the departure of the stupor being attended with a return of delirium for some hours longer. One of Mr Brumwell's patients, too, was delirious for three days; and *Plenck* has noticed several instances where the delirium was equally tedious [¶]. *Sage* has related a case in which the individual was comatose for thirty hours [**]. The blindness is also a very obstinate symptom, which sometimes remains after the affection of the mind has disappeared. This happened in Plenck's cases. In two children whose cases have been described in a late French journal, the eyes were insensible to the brightest light for three days [††]. In general, the dilated state of the pupils continues long after the other symptoms have departed. It further appears from an official narrative in Rust's Journal, that dilated pupil is not the only symptom which may thus continue, but that various nervous affections, such as giddiness, disordered vision, and tremors, may prevail even for three or four weeks [*].

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[*] *Sedillot's* Journal de Médecine, xxiv. 228.

[†] British Herbal, 329.

[‡] Journ. Universel, xxii. 239.—Edin. Med. and Surg. Journal, xxix. 452.

[§] *Plenck's* Toxicologia, 109.

[‖] *Roux's* Journal de Méd. xxiv. 310.

[¶] Toxicologia, 109.

[**] Moyens de remédier aux Pois. Végét.

[††] Journ. de Chim. Méd. iii. 586.

Hitherto little or no mention has been made of symptoms of irritation from this poison. They are in fact uncommon, and seldom violent. In the cases related by Gaultier de Claubry and by Mr Brumwell, dryness and soreness of the throat and difficult deglutition were remarked, and appear not unusual. These symptoms were especially noticed by *Buchner*, who by way of curiosity took half a drachm of seeds digested in beer. The sense of dryness and constriction of the throat were such as to prevent him swallowing even the saliva. [†] Sage's patient passed blood by stool; and after the symptoms of narcotic poisoning ceased, he had aphthous inflammation in the throat, and swallowing was so difficult as for some time to excite convulsive struggles. Aphthæ in the throat and swelling of the belly also succeeded the delirium in *Munnik's* case. *Mr Wilmer* alludes to the case of a man who, besides difficult deglutition at the beginning, had violent strangury towards the close [‡]. An instance of violent strangury with suppression of urine and bloody micturition is also related by *M. Jolly*. In the early stage, the patient had redness of the throat and burning along the whole alimentary canal, combined with the customary delirium and loss of consciousness. The symptoms were caused by forty-six grains of the extract given by mistake instead of jalap [§]. Nausea and efforts to vomit are not infrequent at the commencement.

If the accident is taken in time, poisoning with belladonna is rarely fatal; for, as the state first induced is delirium, not sopor, suspicion is soon excited, and emetics may be made to act before a sufficient quantity of the poison has been absorbed to prove fatal. Hence no fatal instances have occurred in recent times. *Mr Wilmer*, however, has mentioned two fatal cases occurring in children, and terminating within twenty-four hours [||]. *M. Boucher*, a writer in the old French Journal of Medicine, has referred to several cases of the same nature [*]; *Gmelin* has described the particulars of a good example [†]; and many others have been succinctly quoted by *Wibmer*, chiefly from the older authors [‡].

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[*] Magazin für die gesammte Heilkunde, xxi. 550.

[†] Toxikologie, p. 220.

[‡] On Vegetable Poisons, 17.

[§] Nouvelle Biblioth. Méd. 1828, iii.

[||] On Ve getable Poisons, p. 18.

Cases of poisoning with this plant have occurred in man through other channels besides the stomach. Allusion has already been made to the instance of a tailor who was poisoned by an injection. A small quantity will sometimes suffice when administered in that way. A woman, whose case is mentioned in Rust's Journal, was attacked with wild delirium, flushed face and glistening eyes, in consequence of receiving, during labour, a clyster that contained six grains of the common extract [§].

Perhaps the berry is in some circumstances not very active. A French physician, *M. Gigault* of Pontcroix, says he has frequently had occasion to treat cases of poisoning with it, as accidents of the kind are extremely common in his neighbourhood; that he never knew it prove fatal; and that in one instance a young man took a pound of the berries before going to bed, and was not subjected to treatment till next morning, when he was found in a state of delirium, but speedily recovered after the free operation of emetics [||].

Morbid Appearances.—I have hitherto seen but one good account of the appearances after death from poisoning with belladonna. It is described by *Gmelin.* The subject was a shepherd who died comatose twelve hours after eating the berries. When the body was examined twelve hours after death, putrefaction had begun, so that the belly was swelled, the scrotum and penis distended with fetid serum, the skin covered with dark vesicles, and the brain soft. The blood-vessels of the head were gorged, and the blood everywhere fluid, and flowing profusely from the mouth, nose, and eyes [¶]. In the only other fatal case I have read, where the body was inspected, there appears to have been no unusual appearance at all [**].

As the husks and seeds of the berries are very indigestible, some of them will almost certainly be found in the stomach, as happened in the instance last quoted. It should likewise be remembered that the best possible evidence of the cause of the symptoms may be derived during life from the presence of the seeds, husks, or even entire berries in the discharges. If vomiting has not been brought on at an early period we may expect to find these remains both in the vomited matter and in the alvine evacuations. *Mr Wilmer* mentions an instance in which the black husks appeared in the stools brought away by laxatives at least thirty hours after the poison was swallowed *. One of *Mr Brumwell's* patients vomited the seeds towards the close of the third day †. Several patients of *M. Boucher* vomited fragments of the fruit on the second day, and passed more by stool and injections on the third, although they had been treated with activity from the commencement ‡.

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[*] *Roux's* Journal de Med. xxiv. 321.

[†] Geschichte der Pflanzengifte, p. 538.

[‡] Die Wirkung der Arzneimittel und Gifte, i. 347–364.

[§] Mag. für die gesammte Heilk. xxv. 578.

[||] Journal de Chim. Méd. iv. 390.

[¶] Geschichte der Pflanzengifte, p. 538.

[**] Histoire de l'Acad. de Paris, 1703, p. 69.

While most of the cases of poisoning with belladonna have originated in accident, at the same time they have not been all of this description. *Gmelin* has quoted an instance of intentional and fatal poisoning by the juice of the berries being mixed with wine; and another singular case of poisoning with the decoction of the buds given by an old woman for the purpose of committing theft during the stupor of the individual §.

Other species of Atropa are probably similar to belladonna in properties. *Wibmer* quotes a singular instance of frantic delirium occurring among several shepherds, as well as their cattle, from eating the herb of the *A. Mandragora* ‖. This is well known to have been used anciently as a medicinal narcotic.

Of Poisoning with Thorn-Apple.

The Thorn-apple, or *Datura Stramonium*, is another plant of the same natural order, which it is proper to notice, because people have often been poisoned with it, and it has become a common ornament of our gardens. The cases of poisoning which have occurred in recent times and in this country have been all of them accidental. But not long ago the thorn-apple appears to have been extensively used in Germany to cause loss of consciousness and lethargy, preparatory to the commission of various atrocious crimes[*]; and I am informed by *Mr Henry Marshall*, that it is still used in the East for the purpose of concealing theft.

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* On Vegetable Poisons, p. 21.

† Med. Obs. and Inq. vi. 224.

‡ Roux's Journ. de Méd. xxiv. 317.

§ Geschichte des Pflanzengifte, 527.

‖ Die Wirkung der Arzneimittel, &c. i. 378.

It is chiefly the fruit and seeds that have hitherto been examined; but the whole plant is probably poisonous. *Brandes* discovered in it a peculiar alkaloid, which he named Daturine or Daturia[†]; and which has been since detached in a more pure state by *Dr Bley*. This is a volatile, oily-like substance analogous to the oleaginous alkaloids, separated by Brandes from hyoscyamus and belladonna. It smells powerfully of stramonium[‡]. *Dr Morries* obtained from the thorn-apple by destructive distillation an empyreumatic oil similar in properties to that of hyoscyamus. *Geiger* and *Hesse* have obtained a colourless, crystalline alkaloidal substance, of an acrid taste like tobacco, which is probably the true daturia[§].

The physiological effects of the extract have been determined by Orfila. He found that half an ounce killed a dog within twenty-four hours after being swallowed, that a quarter of an ounce applied to a wound killed another in six hours, and that thirty grains killed another when injected into the jugular vein. The symptoms were purely nervous, and not very prominent. Hence this poison, like the former, acts through the blood-vessels, and probably on the brain[‖]. Bley's daturia proves quickly fatal to small animals in the dose of a few drops. The crystalline daturia of Geiger and Hesse kills a sparrow in the dose of an eighth of a grain, and occasions great and persistent dilatation of the pupil when applied to the eye.

Symptoms in Man.—The symptoms produced by a poisonoüs dose in man are variable. The leading features are great delirium, dilatation of the pupils, and stupor; but sometimes spasms, and occasionally palsy occur.

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[*] *Gmelin*, Geschichte der Pflanzengifte, 416. As examples of such crimes he mentions the following. *Diebe und Huren um ihr Verbrechen desto ungehinderter zu begehen wenn sie die Leute damit eingeschläfert haben; Hurenwirthinnen, um in ihren gemietheten Mägdchen alles Gefühl der natürlichen Schaam zu ersticken; alte Hurer um junge Mägdchen zu verführen; Missethäter um ihre Wächter sinnlos zu machen; Ehebrecherinnen, um ihre Männer zu ruhigen Zuschauern ihrer Schandthaten zu machen.* For most of these purposes gin and whisky are the instruments of villany in Britain; and of late, as already mentioned, opium has been resorted to.

[†] *Schweigger's* Journal, xxvi. 98.

[‡] Annalen der Pharmacie, iii. 135.

[§] Journal de Pharmacie, xx. 94.

[‖] Orfila, Tox. ii. 271.

Dr Fowler has related the case of a little girl who took a drachm and a half of the seeds. In less than two hours she was attacked with maniacal delirium, accompanied with spectral illusions; and she remained in this state most of the following night, but had some intervals of lethargic sleep. Next morning, after the operation of a laxative, she fell fast asleep, and awoke after some hours quite well *.

In two instances, one related by *Vicat* in his treatise on the poisonous plants of Switzerland †, the other by *Dr Swaine* ‡ in the Edin. Phys. and Lit. Essays, the leading symptoms were furious delirium and palsy of the whole extremities. In the instances of three children related by *Alibert* there were delirium, restlessness, constant incoherent talking, dancing and singing, with fever and flushed face §. In another recorded by *Dr Young*, there were some convulsions, and livid suffusion of the countenance ||. In an instance communicated to me by my colleague *Dr Traill*, where eighteen or twenty grains of extract of stramonium were taken by mistake for extract of sarsaparilla, the symptoms were dryness of the throat immediately afterwards, then giddiness, dilated pupils, flushed face, glancing of the eyes, and incoherence, so that he seemed to his friends to be intoxicated; and subsequently there was incessant unconnected talking like that of demency. Emetics were given without effect, and little amendment was obtained from blood-letting, leeches to the temples, cold to the head, or purgatives. But after a glass of strong lemonade vomiting took place, the symptoms began to recede, in ten hours he recognized those around him, and next day he was pretty well. *Kaauw Boerhaave* has related with great minuteness the case of a girl who very nearly lost her life in consequence of a man having given her the powder in coffee with the view of seducing her. The symptoms were redness of the features, delirium, nymphomania, loss of speech; then fixing of the eyes, tremors, convulsions, and

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* Edin. Medical Commentaries, v. 163.

† Orfila, Toxicol. Gén. ii. 247.

‡ Edin. Phys. and Lit. Essays, ii. 272.

§ *Corvisart's* Journ. de Méd. xxiii. 157.

|| Edin. Med. and Surg. Journal, xv. 154.

coma; afterwards tetanic spasm and slow respiration with the coma. She was with much difficulty roused for a time by the operation of emetics, and eventually got well after her lethargy had lasted nearly a day [*]. In another related in Rust's Magazin, and caused by a decoction of the fruit, which was mistaken for thistle-heads, the leading symptoms were spasmodic closing of the eyelids and jaws, spasms also of the back, complete coma, and excessive dilatation and insensibility of the pupil [†]. This case, which seems to have been a very dangerous one, was rapidly cured by free blood-letting. Blood-letting, indeed, seems peculiarly called for in poisoning with the thorn-apple, on account of the strong signs of determination of blood to the head.—*Gmelin* has quoted several fatal cases, one of which endured for six hours only [‡]; and Dr Young says that a child has been killed by a single apple [§]. The most complete account yet published of the phenomena of poisoning with stramonium when fatal is given by *Mr Duffin* of London. A child of his own, two years old, swallowed about 100 seeds without chewing them. Soon after she became fretful and like a person intoxicated; in the course of an hour efforts to vomit ensued, together with flushed face, dilated pupils, incoherent talking, and afterwards wild spectral illusions and furious delirium. In two hours and a half she lost her voice and the power of swallowing, evidently owing to spasms of the throat. Then croupy breathing and complete coma set in, with violent, spasmodic agitation of the limbs, occasional tetanic convulsions, warm perspiration, and yet an imperceptible pulse. Subsequently the pulse became extremely rapid, the belly tympanitic, and the bladder paralyzed, but with frequent involuntary stools, probably owing to the administration of cathartics; and death took place in twenty-four hours. At an early period twenty seeds were discharged by an emetic; the stools contained eighty; and none were found in the alimentary canal after death. There was never any marked sign of congestion of blood in the head, except flushed face at the beginning [||].

Dangerous effects may result from the application of the thorn-apple to the skin when deprived of the cuticle. An instance has been lately published of alarming narcotism from the application of the leaves to an extensive burn [*].

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[*] Gmelin, Gesch. der Pflanzengifte, 421.

[†] Magazin für die gesammte Heilkunde, xvii. 564.

[‡] Gmelin, 420.

[§] Edin. Med. and Surg. Journal, xv. 154.

[||] London Medical Gazette, xv. 320.

Morbid Appearances.—As to the *Morbid Appearances*, *Haller* says he once found general congestion of the brain and sinuses [†],—an appearance which may naturally be expected, considering the signs of strong determination of blood towards the head, which often prevail during life. In *Mr Duffin's* case, however, the brain was healthy, not congested; the stomach and intestines presented no morbid appearance; and the only unusual appearances observed were a slight blush over the pharynx, larynx, and upper third of the gullet, thickening and swelling of the rima glottidis, and a semi-coagulated state of the blood.

Of Poisoning with Tobacco.

A plant of the same natural order with the two former, Tobacco, the *Nicotiana Tabacum* of botanists, is familiarly known to be in certain circumstances a virulent poison. Every part of the plant possesses active properties.

Vauquelin analyzed it some time ago, and procured an acrid volatile principle which he called Nicotine [‡]. *Hermbstädt* afterwards examined it also, discovered that Vauquelin's principle is impure, and thought he found the true active principle in a white, crystalline, foliated substance, very fusible and easily volatilized. This substance, to which he gave the name of Nicotianine, has been more recently ascertained by *MM. Posselt* and *Reimarus* to be nothing else than essential oil of tobacco, which is solid at ordinary temperatures; and they succeeded in procuring another principle which they consider the true Nicotianine. This is fluid at 29° F., volatile, extremely acrid, alkaline and capable of forming crystallizable salts with some of the acids [§]. Tobacco then appears to contain an acrid, alkaline principle, and an essential oil to which the alkaloid adheres with great obstinacy. The relation of the empyreumatic oil of tobacco to these principles has not been accurately ascertained, though it probably contains one or other of them. It is well known to be an active poison, which produces convulsions, coma and death. *Dr Morries* found that its active part is removed from the oil by washing with weak acetic acid, as he has also observed in the instance of similar oils obtained from various narcotic vegetables *.

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[*] Journal de Chim. Méd. vi. 722.

[†] Hist. Stirp. Helvet. Indig. i. 259.

[‡] *Vauquelin*—Annales de Chimie, lxxi. 139.

[§] Bulletin des Scien. Méd. xii. 177, from *Geiger's* Magazin für Pharmacie, Nov. und Dec. 1828.

The effects of tobacco are somewhat different from those of the Belladonna and Thorn-apple; but it is here arranged with them, as it belongs to the same Natural Family. *Orfila* remarked that 5½ drachms of common rappee introduced into the stomach of a dog and secured by a ligature, caused nausea, giddiness, stupor, twitches in the muscles of the neck, and death in nine hours; and that two drachms and a quarter applied to a wound proved fatal in a single hour †. *Mr Brodie*, however, has found that the effects are very different according to the form in which the poison is used. Thus four ounces of a strong infusion, when injected into the anus of a dog, killed it in ten minutes by paralyzing the heart; for after death the blood in the aortal cavities was arterial. But the empyreumatic essential oil does not act in that manner: It excites convulsions and coma without affecting the heart. It may prove fatal in two minutes ‡. Like other violent poisons, it has no effect when applied directly to the brain or nerves §.

Symptoms in Man.—The effects observed in man are allied to those produced in dogs by the infusion. In a slight degree they are frequently witnessed in young men, while making their first efforts to acquire the absurd practice of smoking. The first symptoms are acceleration and strengthening of the pulse, with very transient excitement, then sudden giddiness, fainting, and great sickness, accompanied with a weak, quivering pulse. These effects are for the most part transient and trifling, but not always. Some degree of somnolency is not uncommon. *Dr Marshall Hall* has given an interesting account of a young man who smoked two pipes for his first debauch, and in consequence was seized with nausea, vomiting, and syncope, then stupor, stertorous breathing, general spasms and insensible pupil. Next day the tendency to faint continued, and in the evening the stupor, stertor, and spasms returned; but from that time he recovered steadily ||. *Gmelin* has quoted two cases of death from

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* Edinburgh Med. and Surg. Journal, xxxix. 382.

† Toxicol. Gén. ii. 275.

‡ Philosophical Transactions, ci. 186, 181.

§ *Macartney.*—Orfila, Toxicol. Gén. ii. 282.

|| Edin. Med. and Surg. Journal, xii. 11.

excessive smoking,—caused in one by seventeen, in the other by eighteen pipes smoked at a sitting [*]. It is likewise mentioned by *Lanzoni* that an individual fell into a state of somnolency and died lethargic on the twelfth day in consequence of taking too much snuff [†]; and *Dr Cheyne* says "he is convinced apoplexy is one of the evils in the train of that disgusting practice [‡];" but this statement is questionable, as the daily experience of every one must testify.

Serious consequences have resulted from the application of tobacco to the abraded skin. In the Ephemerides an account is given of three children who were seized with giddiness, vomiting, and fainting from the application of tobacco-leaves to the head for the cure of ring-worm [§].

The only well authenticated cases in recent times of death from poisoning with tobacco are those produced by the employment of too large doses in the way of injection. Many accidents of this nature have occurred. One has been minutely related by *Dr Grahl* of Hamburg, which arose from an ounce or rather more boiled for fifteen minutes in water, and administered by advice of a female quack. The individual, who laboured merely under dyspepsia and obstinate costiveness, was seized in two minutes with vomiting, violent convulsions, and stertorous breathing, and died in three quarters of an hour [‖]. Another accident of the same kind is noticed in the Journal de Chimie Médicale, where the person became as it were intoxicated and died immediately. Instead of an infusion of two drachms she had used a decoction of two ounces [¶]. Even two drachms, however, are by no means a safe dose. An anonymous writer in the Medical and Surgical Journal says a patient of his died in convulsions an hour or two after receiving a clyster composed of two drachms infused in eight ounces [**]. Nay in the Acta Helvetica there is an account by an anonymous writer of the case of a woman, who, after an injection made with one drachm only, was seized with pain in the belly, anxiety and faintings; and expired in a few hours [*]. *Orfila* says that Santeuil was poisoned by tobacco mixed with his wine; and there is no doubt that it will prove fatal when swallowed; but no accurate case has yet been recorded [†].

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[*] Pflanzengifte, 550.

[†] Ephem. Cur. Nat. Dec. ii.—Ann. x. p. 222.

[‡] On Apoplexy and Lethargy, p. 150.

[§] Ephem. Cur. Nat. Dec. ii.—Ann. iv. p. 467.

[‖] *Hufeland's* Journal der Praktischen Heilkunde, lxxi. iv. 100.

[¶] Journ. de Chim. Méd. iii. 23.

[**] Edin. Med. and Surg. Journal, ix. 159.

Evidence is not wanting, therefore, to prove that this plant is a very active poison; yet every one knows that under the influence of habit it is used in immense quantities over the whole world as an article of luxury, without any bad effect having ever been clearly traced to it. Its poisonous qualities were known in Europe as soon as it was brought from America; and the belief that such properties would not fail to be attended, as in the case of opium, with evil consequences from its habitual use, led to a good deal of opposition on the part of various governments to its introduction. Soon after it was brought to England by Sir W. Raleigh, King James wrote a philippic against it, entitled "The Counter-blaste to Tobacco." Some countries even prohibited it by severe edicts. Amurath the 4th in particular made the smoking of tobacco capital; several of the Popes excommunicated those who smoked in the church of St Peter's; in Russia it was punished with amputation of the nose; and in the Canton of Bern it ranked in the tables next to adultery, and even so lately as the middle of last century a particular court was held there for trying delinquents [‡]. Like every other persecuted novelty, however, smoking and snuff-taking passed from place to place with rapidity; and now there appear to be only two luxuries which yield to it in prevalence, spirituous liquors and tea.

The only good account I have seen of the morbid appearances after poisoning with tobacco is contained in the case described by *Dr Grahl.* There was great lividity of the back, paleness of the lips, flexibility of the joints, (two days after death,) diffuse redness of the omentum without gorging of vessels, similar redness with gorging of vessels both on the outer and inner coats of the intestines, in some parts of the mucous coat patches of extravasation, unusual emptiness of the vessels of the abdomen; while the stomach was natural, the lungs pale, the heart empty in all its cavities, and the brain natural.

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[*] Acta Helvetica, 1762, v. 330.

[†] Toxicol. Gén. ii. 280.

[‡] Paris and Fonblanque's Medical Jurisprudence, ii. 415.

Writers on the diseases of artizans have made many vague statements on the supposed baneful effects of the manufacture of snuff on the workmen [*]. It is said they are liable to bronchitis, dysentery, ophthalmia, carbuncles and furuncles. At a meeting of the Royal Medical Society of Paris, however, before which a memoir to this purport was lately read, the facts were contradicted by reference to the state of the workmen at the Royal Snuff Manufactory of Gros-Caillou, where 1000 people are constantly employed without detriment to their health [†]. This subject has been since investigated with great care by *MM. Parent-Duchatelet* and *D'Arcet*, who inquired minutely into the state of the workmen employed at all the great tobacco-manufactories of France, comprising a population of above 4000 persons; and the results at which they have arrived are,—that the workmen very easily become habituated to the atmosphere of the manufactory,—that they are not particularly subject either to special diseases, or to disease generally,—and that they live on an average quite as long as other tradesmen [‡]. These facts are derived from very accurate statistical returns, showing the number of days each person is annually off work from sickness, the ages at which superannuated allowance has been granted, the period of death, and the prevalent diseases.

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[*] *Rammazini*, de Morb. Opificum, 535.—*Fourcroy*, Essai sur les Mal. des Artizans, 89.—*Patissier*, Traité des Mal. des Art. 202.

[†] Revue Médicale, 1827, iii. 168.

[‡] Annales d'Hygiène Publique et de Méd. Lég. i. 169. 1829.

CHAPTER XXXIV.

OF POISONS OF THE UMBELLIFEROUS ORDER OF PLANTS.

THE natural order of the *Umbelliferæ* contains many plants possessed of narcotico-acrid properties. The leading symptoms they produce are delirium, convulsions, and coma; but several have also distinct irritating properties.

Of Poisoning with Hemlock.

The first to be mentioned is the Common Hemlock, or *Conium maculatum*, one of the most abundantly diffused of the umbelliferous vegetables. It is distinguished from all those which it resembles by its tall, smooth, spotted stem. Cases of poisoning caused by it in man are not infrequent, the root having been mistaken for fennel, asparagus, parsley, but particularly parsnep [*]. It is generally believed to have furnished the poison which was used in ancient times and especially among the Greeks for dispatching criminals; but we have not any precise information on the subject.

A peculiar alkaloid was indicated in Hemlock not long ago by *Brandes*, half a grain of which killed a rabbit with symptoms like those of tetanus [†]. Other chemists were unable to obtain his results. But the subject has been more lately taken up with success by *Geiger*, who obtained from it a volatile oil, possessing alkaloidal properties, eight drops of which administered to a strong dog occasioned vomiting, extension of the limbs, general convulsions, and death in six minutes [‡]. I have repeated the analysis of Geiger, and obtained the same results; but the poisonous effects of the alkaloid have appeared to me very peculiar and different from what has been represented both by Brandes and by Geiger. Dr Morries obtained from hemlock by destructive distillation an empyreumatic oil similar in properties to those of hyoscyamus, stramonium and tobacco, but producing in animals a state of pure coma [§].

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[*] Gmelin's Pflanzengifte, S. 598.

[†] Philosophical Magazine, N. S. iv. 231.

[‡] *Geiger's* Magazin für Pharmacie, xxxv. 72. 259.

[§] Edin. Medical and Surgical Journal, xxxix. 383.

The effects of hemlock on the animal system appear to be sometimes purely soporific like those of opium; at other times they are like the effects of belladonna and thorn-apple; and in the lower animals it has seemed to me to act very differently from what is usually conceived to be its action on man,—the phenomena being simply those of asphyxia from paralysis of the muscles, without material convulsions and without insensibility. Its irritant action is not well established.

Orfila observed that an ounce of the extract of the leaves killed a dog in forty-five minutes when swallowed, ninety grains killed another through a wound in an hour and a half, and twenty-eight grains another through a vein in two minutes. It therefore acts by entering the blood-vessels. He likewise remarked, that the extract is a very uncertain preparation; the reason of which, according to *Geiger*, is that the alkaloid conia is very easily decomposed in its natural state of mixture, being converted into an inert resinoid matter,—that the dried leaves of hemlock contain scarcely any of it,—and that even an extract of the fresh leaves contains very little, unless prepared with a gentle heat, yet speedily *. The symptoms remarked by Orfila were convulsions and insensibility; and in the dead body the blood of the left cavities of the heart was sometimes found arterial. In various experiments with a very strong extract prepared from the green seeds with absolute alcohol, the only effects I could remark were palsy first of the voluntary muscles, next of the chest, lastly of the diaphragm,—asphyxia in short from paralysis, without insensibility, and with slight occasional twitches only of the limbs. The heart was always found contracting vigorously for a long time after death. Thirty grains of a soft extract introduced between the skin and muscles of the back killed a rabbit in five minutes, and a five months' puppy in twenty minutes. The root appears, from *Orfila's* experiments, not to be so active as is imagined by some authors. Two pounds, however, gathered on the last day of May killed a dog in six hours. It is probably strongest when the plant is in full vegetation; for in April three pounds had no effect whatever †. These facts may account for various persons having found the juice of the root harmless. *Gmelin* quotes an instance where four ounces of the juice were taken without injury, and another where three ounces of the juice of the herb were swallowed daily for eight days with as little effect. But, as he judiciously observes, other less active plants have probably been sometimes mistaken for hemlock *.

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* Magazin für Pharmacie, xxxv. 284.

† Toxicol. Gén. ii. 303.

Geiger has not brought forward distinct evidence that his conia is the true active principle of hemlock. But from a considerable number of experiments both with the alkaloid and with its salts I am satisfied that it produces in animals the very same effects as the alcoholic extract mentioned above. It is a poison of extraordinary energy. Two drops neutralized with muriatic acid killed a rabbit in one minute when dropped between the skin and muscles of the back; and six drops of the pure alkaloid dropped into the throat of a puppy killed it in as short a time †.

Symptoms in Man.—*M. Haaf*, a French army surgeon, has described a fatal case of poisoning with hemlock, which closely resembled poisoning with opium. The subject of it, a soldier, had partaken along with several comrades of a soup containing hemlock leaves, and appeared to them to drop asleep not long after, while they were conversing. In the course of an hour and a half they became alarmed on being all taken ill with giddiness and headach; and the surgeon of the regiment was sent for. He found the soldier, who had fallen asleep, in a state of insensibility, from which, however, he could be roused for a few moments. His countenance was bloated, the pulse only 30, and the extremities cold. The insensibility became rapidly deeper and deeper, till he died, three hours after taking the soup ‡. His companions recovered.

Dr Watson has briefly described two cases which were fatal in the same short space of time. The subjects were two Dutch soldiers, who, in common with several of their comrades, took broth made with various herbs, and among the rest hemlock leaves. Giddiness, coma, and convulsions were the principal symptoms. The men who recovered were affected exactly as if they had taken opium[*].

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* Pflanzengifte, S. 605.

† The results of these experiments with their details, which have appeared to me of interest, were it for no other reason than that they prove conia to be a poison of very peculiar properties, and exceeding energy, will be published speedily in another form.

‡ *Corvisart's* Journal de Méd. xxix. 107.

When the dose is not sufficient to prove fatal, there is sometimes paralysis attended with slight convulsions, as in a case noticed by Orfila[†]. More commonly there is frantic delirium. *Matthiol* has related an instance of this last description, occurring in the cases of a vine-dresser and his wife, who mistook the roots for parsneps. Both of them became in the course of the night so delirious that they ran about the house, knocking themselves against every object which came in their way[‡]. *Kircher*, as quoted by Wibmer, tells a parallel story of two monks who became so raving mad after eating the roots, that they plunged into water, imagining they were turned into geese, and they were affected for three years with incomplete palsy and neuralgic pains[§]. These and some other cases of the like kind recorded by the older medical authors must be received with some reserve. Independently of other considerations, there is often no certainty that the poison was really the hemlock of modern botanists, and not some other umbelliferous vegetable.

Morbid Appearances.—In Haaf's case the vessels of the head were much congested; and the blood must have been very fluid, for on opening the head a quantity flowed out, which twice filled an ordinary chamber-pot. This state of the blood likewise occurred in a case which I examined here some years ago along with *Dr C. Coindet* of Geneva. A hypochondriacal old woman took by advice of a neighbour two ounces of a strong infusion of hemlock leaves with the same quantity of whisky, which she swallowed in the morning fasting. She died in an hour, comatose and slightly convulsed. The vessels within the head were not particularly turgid; but the blood was everywhere remarkably fluid. Dr Coindet subsequently found that a small portion of the infusion prevents fresh drawn blood from coagulating; but I suspect there must have been some mistake here, for a carefully prepared alcoholic extract of very great power, which was used in my experiments alluded to above, had no such effect on blood fresh drawn from rabbits and dogs. On account of this extreme fluidity of the blood, it often flows from the nose, and the skin is much marked with lividity [*]. The fluidity of the blood is I suspect nothing more than the result of the proximate cause of death,—slowly formed asphyxia.

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[*] Philos. Transactions, xliii. No. 473, p. 18.

[†] Toxicol. Gén. ii. 311.

[‡] *Gmelin's* Pflanzengifte, p. 604.

[§] Die Wirkung der Arzneimittel und Gifte, i. 172.

Of Poisoning with Water-Hemlock.

Another plant of the order Umbelliferæ, the Water-Hemlock or *Cicuta Virosa*, possesses even more energy as a poison; and in its effects it appears to resemble considerably the hydrocyanic acid. The plant is indigenous.

From a numerous set of experiments with the root of the Cicuta performed by *Wepfer*, it appears to cause true tetanic convulsions in frequent paroxysms, and death on the third day [†]. *Schubarth* found that an ounce of the juice of the stems and leaves collected after the flowers had begun to blow produced no effect on the dog [‡].

Symptoms in Man.—Wepfer has likewise related several instances which occurred in the human subject. Among the rest he has described the cases of eight children who ate the roots instead of parsneps. Of those who were seriously affected one, a girl six years old, who ultimately recovered, had tetanic fits, followed by deep coma, from which it was impossible to rouse her for twenty-four hours. Two of them died. The first symptoms in these two were swelling in the pit of the stomach, vomiting or efforts to vomit, then total insensibility, involuntary discharge of urine, and finally severe convulsions, during which the jaws were locked, the eyes rolled, and the head and spine were bent backwards, so that a child might have crept between the body and the bed-clothes. One of them died half an hour after being taken ill, the other not long after [§].

According to *Guersent*, poisoning with the cicuta commences with dimness of sight, giddiness, acute headach, anxiety, pain in the stomach, dryness in the throat, and vomiting [||].

Mertzdorff has related the particulars of the inspection of three cases which proved quickly fatal with convulsions and vomiting. Nothing remarkable seems to have been found except great gorging of the cerebral vessels [¶].

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[*] *Gmelin's* Pflanzengifte, p. 603.

[†] Cicut. Aquaticæ Hist. et Noxæ, 134.

[‡] Archiv für Medizin. Erfahr. 1824, i. 84.

[§] Cic. Aquat. &c. 80, and 107.

[||] Article *Cigue*, Diction. des Sciences, Méd.

[¶] Journal Complémentaire, xvii. 361.

Of Poisoning with Hemlock Dropwort.

The Dead-tongue or Hemlock Dropwort, the *Œnanthe crocata* of botanists, a plant of the same family, and a native of this country, is even more active than the Cicuta. It has an abundant, milky, acrid juice. The plant, according to *Godefroi*, is apt to be mistaken for hemlock by collectors of medicinal vegetables,—a mistake of serious consequence; for even a single medicinal dose of the extract, taken instead of extract of hemlock, might prove fatal [*].

Symptoms in Man.—*Orfila* has collected a great number of fatal cases of poisoning with the Œnanthe, from which it appears that the usual symptoms are heat in the throat and stomach, delirium, stupor, hardly ever proper coma, but generally convulsions, more or less violent [†]. *Mr Howell* has mentioned the substance of eleven cases, which happened near Pembroke, and of which two proved fatal. The symptoms were convulsions, without any previous symptom or warning [‡], *Ray* has described eight other cases, which arose from the dropwort having been mistaken for water-parsneps. Five of the people died; and they were seized with convulsions suddenly without any warning symptom. Another became furiously maniacal, but recovered his senses next day [§]. *Mr Watson* has related an instance which proved fatal in three hours and a half, although the symptoms did not begin till an hour and a half after the poison was taken [‖]. *Mr Houlston* has given the particulars of the case of a boy, nine years old, who ate the roots by mistake for the ground-nut, and died in four hours, though part of the poison was expelled by emetics. The symptoms were first giddiness, afterwards coma and violent convulsions; and after death a handful of the root was found in the stomach, where also the peculiar smell of the poison was distinctly remarked [¶].

It seems to be the most energetic of the umbelliferous vegetables. In none of the fatal cases was life prolonged beyond three hours and a half, and in several death took place within an hour. One man was killed by a single spoonful of the juice of the root.

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[*] Journal de Pharmacie, viii. 170.

[†] Toxicol. Gén. ii. 206.

[‡] Philos. Trans. xliv. 227.

[§] Ibidem, xx. 84.

[‖] Ibid. i. 856.

[¶] London Medical Journal, ii. 40.

Of Poisoning with Fool's Parsley.

Another umbelliferous plant of great activity is Fool's Parsley, or *Æthusa cynapium.* It has occasioned many accidents by reason of its resemblance to parsley,—from which, however, it is at once distinguished by the leaves being dark and glistening on their lower surface, and by the nauseous smell they emit when rubbed. It contains an alkaloid, which crystallizes in rhombic prisms, and is soluble in water and alcohol, but not in ether. It was discovered by *Professor Ficinus* of Dresden [*].

Orfila found that six ounces of the juice, when retained in the stomach of a dog by a ligature, caused convulsions and stupor, and death in an hour [†].

Symptoms in Man.—Some interesting information on the characters and properties of this plant is contained in the Medical and Physical Journal. Among other cases the writer relates those of two ladies who ate a little of it in a sallad, having mistaken it for parsley, and who were soon seized with nausea, vomiting, headach, giddiness, somnolency, pungent heat in the mouth, throat, and stomach, difficulty in swallowing, and numbness of the limbs [‡]. *Gmelin* has related the case of a child, who died in eight hours in consequence of having eaten the æthusa. The symptoms were spasmodic pain in the stomach, swelling of the belly, lividity of the skin, and difficult breathing [§]. In two children who recovered the chief symptoms at the height of the poisoning were complete insensibility, dilated, insensible pupil, and staring of the eyes. In one of them there was also frequent vomiting, in the other convulsions. The treatment consisted in the administration of milk, sinapisms to the legs, and cold spunging with vinegar [‖].

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[*] Lond. Philos. Magazine, N. S. ii. 392.

[†] Toxicol. Gén. ii. 323.

[‡] London Med. and Phys. Journal, xiv. 425.

[§] Geschichte der Pflanzengifte, 571.

[‖] *Wittke* in Magazin für Pharmacie, xxxii. 228.

CHAPTER XXXV.

OF POISONS OF THE ORDER RANUNCULACEÆ.

THE poisons of the natural order of *Ranunculaceæ* are most of them Acrid only in their action; but two of them possess distinctly the characters of the Narcotico-Acrids,—*Monkshood* and *Black Hellebore*. With these may also be arranged *Ipecacuan*, or more properly speaking its principle *Emeta*.

Of Poisoning with Monkshood.

The Monkshood, or *Aconitum napellus*, is an active poison, and a true narcotico-acrid. Every part of the plant is poisonous. But its energy appears to vary in different countries. It has been supposed by *M. Peschier* to contain a peculiar alkaloid, the Aconita; which forms crystallizable salts with acids, and possesses the poisonous qualities of the plant which yields it [*]. More lately *Geiger* and *Hesse* have obtained a white powdery principle, of a bitter taste, fusible not volatile, alkaloidal, soluble in ether and alcohol, sparingly so in water, and highly poisonous [†].

The extract of the leaves, which is the preparation most generally known, varies very much in strength. *Orfila* found that half an ounce of one sample, prepared in the usual way from a decoction of the leaves, had no effect whatever on a dog; that two drachms of another specimen proved fatal in twenty-four hours, giddiness and starting being the chief symptoms; and that two drachms of an extract carefully prepared from the expressed juice occasioned death in two hours, with palsy of the hind-legs, great weakness, staggering, and convulsive twitches of the head, but without insensibility. Five drachms of the root killed a dog in twenty-one minutes. A drachm and a-half of the extract of the juice killed a dog in three hours when applied to the cellular tissue. The common extract occasioned death through that channel more slowly, and in general excited spreading inflammation like the vegetable acrids. It is much more rapidly fatal when introduced at once into the blood, thirty-six grains of a weak extract having in one experiment caused death in four minutes *. The aconita of Geiger and Hesse in the dose of a 50th of a grain will kill a sparrow in a few minutes; and a tenth of a grain proves fatal instantaneously.

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[*] Trommsdorff's Neues Journal der Pharmacie, v. 84.

[†] Journal de Pharmacie, xx. 165.

Symptoms in Man.—Few cases of poisoning with Monkshood in the human subject have been recorded. But accidents with it are not uncommon; and *Valentini* has mentioned one case which occurred at Copenhagen of murder by poisoning with this substance †.

Mr Brodie remarked, on chewing the leaves, a singular numbness in the lips ‡; and I have noticed a very peculiar concurrence of numbness and intense tingling in the lips and tongue from chewing a single seed or a minute portion of the leaves of some species. Some of the cases of poisoning to be found in authors have exhibited symptoms of a decided narcotic action; while in others, death took place under the characteristic effects of the pure acrid poisons.

A very dangerous case, but not fatal, is recorded in the Philosophical Transactions. The symptoms were first tingling in the jaws, extending subsequently over the whole body, and accompanied with a sensation as if of swelling of the face, then twitching of the muscles, fixing of the eyes, locked-jaw, and failure of the pulse and breathing, but without any aberration of mind §. *Willis* mentions a case of poisoning with monkshood, the chief symptom of which was maniacal delirium; and it proved fatal ‖. *Moræus*, a Swedish author quoted by *Wibmer*, gives an account of a similar case: A man after eating a little of the fresh herb became delirious, and a surgeon was sent for. The surgeon ate by way of brag a considerable quantity, and died comatose, while his patient recovered ¶. To the same class of cases probably belongs an extraordinary instance related by *Matthiol*, of an experiment he performed with the root of this plant on a criminal who was condemned to be hanged, but who consented to try the efficacy of a pretended antidote, on condition of being pardoned if he recovered. He took two doses of a drachm each, with an interval of an hour and a-half between them. Three hours after the second, he was attacked with excessive weakness and weariness, and not long afterwards with a convulsive movement of the mouth, eyes, and neck, then with fainting and vomiting, and immediately with stupor, which was soon followed by death [*]. The convulsions did not begin till the counter-poison was given, the nature of which is not mentioned.

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* Toxicologie Générale, ii. 211.

† Pandectæ Medico-Legales, 141.

‡ Phil. Trans. ci. 183.

§ Ibid. xxxviii. 287.

‖ De Anima Brutorum, 289.

¶ Die Wirkung der Arzneimittel und Gifte, i. 30.

M. Pallas, in a thesis published at Paris in 1822, has related several distinct examples of the irritant action of monkshood. Three out of five persons, who took a spirituous infusion of the root, which had been mistaken for lovage, died in two hours with vomiting, purging, and burning in the throat, colic, and swelling of the belly [†]. A similar set of cases have been published, which were also caused by a tincture made with aconite instead of lovage. An old woman who prepared the cordial, took two ounces and a-half in three portions about midnight, and died before morning. Three other individuals of the family took each an ounce, and in half an hour were attacked with burning pain from the throat to the stomach, colic, and tenderness of the abdomen, a sense of enlargement of the tongue and swelling of the face, vomiting and purging. One had afterwards delirium, manifesting itself in loud cries and violent running, but recovered in two days after the free operation of emetics. The two others died, one in two hours, the other half an hour later [‡]. The tincture of the fresh root, therefore, seems a very active preparation. In farther proof of the acrid properties of this plant, it may be added that the external application of the leaves will sometimes blister the skin [§], and the introduction of the juice into a wound in a limb causes extensive inflammation of the surrounding parts [‖].

The only descriptions I have seen of the appearances in the dead body were taken from the cases of Pallas, and from those last mentioned. In the last the stomach and small intestines were very red. In the first, the gullet and rectum were also red, the lungs dense, dark, and gorged, and the cerebral vessels turgid.

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[*] *Gmelin's* Pflanzengifte, 713.

[†] Toxicol. Gén. ii. 221.

[‡] Journ de Chim. Méd. iii.

[§] *Gmelin's* Pflanzengifte, 717.

[‖] *Alberti*, Jurispr. Med. vi. 724.

All the other species of Aconitum appear to be equally poisonous with the A. napellus. The A. lycoctonum has repeatedly proved fatal to man [*].

Of Poisoning with Black Hellebore.

The Black Hellebore, Melampodium, Christmas-rose, or *Helleborus niger*, is also a true narcotico-acrid poison, belonging to the *Ranunculaceæ*. Its active principle appears from the late researches of *MM. Feneulle* and *Capron*, to be an oily matter containing an acid [†].

Two or three drachms of the root killed a dog in eighteen hours, when swallowed; two drachms killed another in two hours when applied to a wound; and six grains in a wound caused death in twenty-three hours. In all cases the leading symptoms are efforts to vomit, giddiness, palsy of the hind-legs, and insensibility [‡]. Ten grains of the extract introduced into the windpipe killed a rabbit in six minutes [§].

The bulletins of the Medical Society of Emulation mention two characteristic cases, which arose from the ignorance of a quack-doctor. Both persons, after taking a decoction of the root, were seized in forty-five minutes with vomiting, then with delirium, and afterwards with violent convulsions. One died in two hours and a-half, the other in less than two hours [||]. *Morgagni* has related a case which proved fatal in about sixteen hours, the leading symptoms of which were pain in the stomach, and vomiting. The dose in this instance was only half a drachm of the extract [¶]. In a case not fatal, related by *Dr Fahrenhorst*, a German physician, the symptoms were those of irritant poisoning generally, that is burning pain in the stomach and throat, violent vomiting to the extent of sixty times in the first two hours, cramps of the limbs, and cold sweating. The most material symptoms were at this time quickly subdued by sinapisms to the belly and anodyne demulcents given internally; and in four days the patient was well. The dose here was a table-spoonful of the root in fine powder *.

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[*] *Buchner's* Toxikologie, 283.

[†] Journal de Pharmacie, vii. 503.

[‡] *Orfila*, Tox. Gén. ii. 225.

[§] *Schabel*, Diss. Inaug. de Effectibus Veratri albi et Hellebori nigri, p. 8. *Tubing.*

[||] Bullet. de la Soc. Méd. d'Em. Avril 1818.

[¶] De Sedibus et Causis Morborum, Epist. lix. 15.

The morbid appearances in the last case were the signs of inflammation in the digestive canal, particularly in the great intestines. In the cases described in the French bulletins, there was gorging of the lungs, and the stomach had a brownish-black colour, as if gangrenous.

The other species of hellebore have not been carefully examined; but it is probable that they all possess similar properties. The *H. hyemalis* and *viridis* are said by Buchner to be weaker than the *H. niger;* and the *H. fœtidus* is the most poisonous of all †.

Of Poisoning with Ipecacuan.

Ipecacuan is well known as an emetic. It is procured from various plants of the natural family Rubiaceæ, more especially from one or more species of Cephaëlis. It contains a peculiar principle not yet crystallized, which is white, permanent in the air, sparingly soluble in water, easily soluble in alcohol and ether, fusible about 122° F., capable of forming crystallizable salts with acids, and possessing an alkaline reaction on litmus. It was discovered by *M. Pelletier* ‡.

Ipecacuan itself is not known to be a poison; because in consequence of its emetic properties it is quickly discharged from the stomach. But in doses of considerable magnitude it would probably be dangerous. In some constitutions the odoriferous effluvia from the powder induce difficult breathing, anxiety, and imperfect convulsions. I have met with several instances of this singular idiosyncrasy, and one in particular where the subject of it, a surgeon's apprentice, suffered so often and so severely as to be induced to abandon the medical profession. A German physician, *Dr Prieger*, has published a remarkable case of a druggist's servant, who, in consequence of incautiously inhaling the dust of ipecacuan powder, was attacked with a sense of tightness in the chest, vomiting, and soon after an alarming sense of suffocation from tightness of the throat. When these symptoms had continued several hours the uneasiness in the throat was removed after the use of a decoction of uva-ursi and rhatany-root; but the dyspnœa remained several days *.

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* *Wibmer*, Die Wirkung der Arzneimittel und Gifte, iii. 10.

† *Buchner's* Toxikologie, 272.

‡ Recherches Chim. et Physiol. sur l'Ipecacuanha. Journal de Pharmacie, iii. 145.

Its active principle, Emeta, is a powerful poison. Two grains of the pure alkaloid will kill a dog; and the symptoms are frequent vomiting, followed by sopor and coma, and death in fifteen or twenty-four hours. In the dead body the lungs and stomach are found inflamed. The same effects result from injecting it into a vein, or applying it to a wound †. It appears, then, to be a narcotico-acrid. But its irritant properties are so prominent that it might be very properly arranged with the vegetable acrids.

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* *Rust's* Magazin für die gesammte Heilkunde, xxxii. 182.

† *Magendie.* Formulaire pour la Préparation, &c. de plusieurs Nouv. Medicamens. 5eme ed. 67.

CHAPTER XXXVI.

OF POISONING WITH SQUILL, MEADOW-SAFFRON, WHITE HELLEBORE, AND FOXGLOVE.

Squill.

The root of the Squill or *Scilla maritima* possesses the properties of the narcotico-acrids. *Orfila's* experiments on animals, indeed, assign to it only an action on the nervous system. He found that two ounces and a-half of the fresh-root, when secured in the stomach of a dog by a ligature on the gullet, excited efforts to vomit, dilated pupil, and lethargy; and in two hours the animal suddenly fell down in a violent fit of tetanus and expired. From thirty-six grains injected into the jugular vein no effect followed for sixteen hours; when at last, as in the former case, the animal dropped down convulsed and died immediately *.

The effects, however, caused by squill on man leave no doubt that it is also an active irritant; for it causes sickness, vomiting, diarrhœa, gripes, and bloody urine, when given in over-doses. It has likewise produced narcotic symptoms in man. *Lange* mentions an instance of a woman, who died from taking a spoonful of the root in powder to cure tympanitis. She was immediately seized with violent pain in the stomach; and in a short time expired in convulsions. The stomach was found every where inflamed, and in some parts eroded †. Twenty-four grains of the powder have proved fatal ‡. I have seen a quarter of an ounce of the syrup of squills, which is a common medicinal dose, cause severe vomiting, purging and pain.

An acrid principle has been discovered in the squill. A grain of it will kill a dog.

Of Poisoning with White Hellebore and Meadow-Saffron.

The White Hellebore or *Veratrum album*, another species of the same genus, the *V. sabadilla*, and the Meadow-Saffron or

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* Toxicol. Gén. ii. 202.

† Tentamen Physico-medicum de Remediis Brunsv. 176.

‡ *Vogel*—Journal de Physique, lxxv. 194.

Colchicum autumnale, are characteristic examples of the Narcotico-acrids.

They all owe their properties to an alkaloid, which was at one time thought to be the same in all three; but two are now acknowledged, *Veratria* and *Colchicia*. *M. Andral* has found that veratria in small doses excites violent vomiting and purging; in larger doses, or when injected into a vein, though in minute quantity, it causes death by tetanus, without any local symptoms of irritation [*]. It is a most powerful sternutatory. *Geiger* and *Hesse*, the discoverers of colchicia, found that a tenth of a grain dissolved in weak spirit killed a young cat in twelve hours, with diarrhœa, vomiting, and convulsions; and that the stomach and intestines were much inflamed, and blood extravasated throughout their whole course [†].

The veratrum itself is also very poisonous. The best account of its effects is contained in a Thesis by *Dr Schabel*, published at Tübingen in 1817. Collecting together the experiments previously made by Wepfer, Courten, Viborg, and Orfila, and adding a number of excellent experiments of his own, he infers that it is poisonous to animals of all classes,—horses, dogs, cats, rabbits, jackdaws, starlings, frogs, snails, and flies;—that it acts in whatever way it is introduced into the system,—by the stomach, rectum, windpipe, nostrils, pleural membrane of the chest, an external wound, or the veins;—that it produces in every instance symptoms of irritation in the alimentary canal, and injury of the nervous system;—and that it is very active, three grains of the extract applied to the nostrils of a cat having killed it in sixteen hours [‡].

Symptoms in Man.—Its effects on man are similar. A singular account of several cases of poisoning with the root is contained in Rust's Journal. A family of eight people, in consequence of eating bread for a whole week, in which the powder of the root had been introduced by mistake instead of cumin seeds, were attacked with pains in the belly, a sensation as if the whole intestines were wound up into a clue, swelling of the tongue, soreness of the mouth, and giddiness; but they all recovered by changing the bread and taking gentle laxatives [§].

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[*] Journal de Physiol. i. 64.

[†] Journal de Pharmacie, xx. 164.

[‡] De Effectibus Ver. alb. et Hell. nigri. Tubingæ, 1817.

[§] Mag. für die gesammte Heilkunde, xiv. 547.

Another set of cases of a more aggravated nature, though still not fatal, is given in Horn's Archives *. Three people took the root by mistake for Galanga root. The symptoms that ensued were very characteristic of its double action. In an hour they had all burning in the throat, gullet, and stomach, followed by nausea, dysuria, and vomiting; weakness and stiffness of the limbs; giddiness, blindness, and dilated pupil; great faintness, convulsive breathing, and small pulse. One of them, an elderly woman, who took the largest share, had an imperceptible pulse, stertorous breathing, and total insensibility even to ammonia held under the nose. Next day she continued lethargic, complained of headach, and had an eruption like flea-bites. A fatal case is quoted by *Bernt* from Schuster's Medical Journal. A man took twice as much as could be held on the point of a knife, was attacked with violent and incessant vomiting, and lived only from morning till night. The gullet, stomach, and colon were here and there inflamed †.

Several cases of fatal poisoning with the *Colchicum autumnale* or Meadow-Saffron have occurred in consequence of its too free use in the treatment of Gout. In the Edinburgh Journal a case is briefly noticed of a man who took by mistake an ounce and a half of the tincture, and died in forty-eight hours, after suffering much from vomiting, acute pain in the stomach, colic, purging, and delirium ‡. *Bernt* has noticed the cases of two children who were poisoned by a handful of colchicum seeds, and who died in a day, affected with violent vomiting and purging §. *Mr Fereday* of Dudley relates a carefully detailed case of a man who died in forty-seven hours after swallowing by mistake two ounces of the wine of the seeds, and in whom the symptoms were acute pain, coming on in an hour and a half, then retching, vomiting, and tenesmus, feeble pulse, anxious expression, afterwards incessant coffee-coloured vomiting, suppression of urine, excessive weakness of the limbs and feeble respiration, and for a short period before death profuse, dark, watery purging. There was neither insensibility nor convulsions ‖. *Chevallier* has described a similar instance where a vinous infusion of the powder of the root was intentionally administered as a poison, and occasioned in a few minutes burning pain, urgent thirst, frequent vomiting of mucus, and death in three days *. The flowers are not less poisonous than the bulbs and seeds. A case is noticed in Geiger's Journal of poisoning with a decoction of some handfuls of the flowers, where death occurred within twenty-four hours, under incessant colic, vomiting and purging †.

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* Archiv für Mediz. Erfahrung, 1825.

† Beiträge zur Gerichtl. Arzneik. iv. 47.

‡ Edin. Med. and Surgical Journal, xiv. 262.

§ Beiträge, &c. iv. 246.

‖ London Medical Gazette, x. 160.

In the bodies of the children mentioned by Bernt there was considerable redness of the stomach and small intestines; in Geiger's case inflammation of the stomach and duodenum only; in the case mentioned in the Edinburgh Journal, and in that related by Chevallier there was no morbid appearance at all to be found. In Mr Fereday's case the omentum was curled and folded up between the stomach on the one hand, and the liver and diaphragm on the other; the stomach and intestines were coated with much mucus; there was no appearance of inflammation there, but on two points, one in the stomach, the other in the jejunum, a red patch appeared, owing to blood effused between the muscular and peritoneal coats; the bladder was empty, the pleura red, the lungs much gorged, their surface, as well as that of the diaphragm and heart covered with ecchymosed spots; and the skin over most of the body presented patches of a purple efflorescence.

It is probable that the power of the root varies considerably, like that of hyoscyamus and hemlock, according to the season; for *Orfila* has remarked, that three bulbs collected in June had no effect on dogs ‡. Yet it is usually considered most active about that time. *Buchner* mentions that it has been lately found most energetic in the autumn §. The seeds are probably much more active than the root.

Of Poisoning with Foxglove.

Foxglove, or *Digitalis Purpurea*, a plant which is common in this country both as a native and in gardens, possesses powerful and peculiar properties. The leaves are considered its most active part. They contain an alkaloid; but chemists have not fixed its nature with precision. *M. Le Royer* of Geneva procured a pitchy, deliquescent, uncrystallizable substance [*]; but more lately *M. Pauguy* obtained a principle in fine acicular crystals, soluble in alcohol and ether, but insoluble in water, alkaline in its reaction, and of a very acrid taste. This principle is called Digitalin [†]. The leaves, like those of other narcotic vegetables, yield by destructive distillation an empyreumatic oil similar in chemical qualities and physiological effects to the empyreumatic oil of hyoscyamus [‡].

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* Journal de Chimie Médicale, viii. 351.

† Magazin für Pharmacie, xxx. 237.

‡ Toxicol. Gén. ii. 257.

§ *Buchner's* Toxikologie, p. 349.

From an extensive series of experiments on animals by *Orfila* with the powder, extract and tincture of the leaves, foxglove appears to cause in moderate doses vomiting, giddiness, languor, and death in twenty-four hours, without any other symptom of note; but in larger doses, it likewise produces tremors, convulsions, stupor and coma. It acts energetically both when applied to a wound, and when injected into a vein [§].

Symptoms in Man.—Upon man its effects as a poison have been frequently noticed, partly in consequence of its being given by mistake in too large a dose as a medicine, partly on account of the singular property it possesses, in common with mercury, of accumulating silently in the system, when given long in moderate doses, and at length producing constitutional effects, even after it has been discontinued. The effects of a dose somewhat larger than is usually given, are great nausea, frontal headach, sense of disagreeable dryness in the gums and pharynx, some salivation, giddiness, weakness of the limbs, feebleness and increased frequency of the pulse, in a few hours an appearance of sparks before the eyes, and subsequently dimness of vision, and a feeling of pressure on the eye-balls. These effects may be occasioned by so small a dose as two or three grains of good foxglove [‖]. The symptoms arising from its gradual accumulation are in the slighter cases nausea, vomiting, giddiness, want of sleep, sense of heat throughout the body, and of pulsation in the head, general depression, sometimes diarrhœa, sometimes salivation, and for the most part profuse sweating. In more urgent cases convulsions also occur; and it appears from a case mentioned by *Dr Blackall*, that the disorder thus induced may prove fatal. One of his patients, while taking two drachms of the infusion of the leaves daily, was attacked with pain over the eyes and confusion, followed in twenty-four hours by a profuse watery diarrhœa, delirium, general convulsions, insensibility, and an almost complete stoppage of the pulse. Although some relief was derived from an opiate clyster, the convulsions continued to recur in frequent paroxysms for three weeks; in the intervals he was forgetful and delirious; and at length he died in one of the convulsive fits *.

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[*] Bibliothèque Universelle de Génève, xxvi. 102.

[†] *Duncan's* Supplement to the Dispensatory, p. 49.

[‡] *Dr Morrice*, Edin. Med. and Surg. Journal, xxxix. 377.

[§] Toxicologie Gén. ii. 286.

[‖] *Wibmer*. Die Wirkung, &c. ii. 312, from *Schroek*, de Digit. Purpurea, 1829.

A case which exemplifies the effects of a single large dose is related in the Edinburgh Journal. An old woman drank ten ounces of a decoction made from a handful of the leaves in a quart of water. She grew sick in the course of an hour, and for two days she had incessant retching and vomiting, with great faintness and cold sweats in the intervals, some salivation and swelling of the lips, and a pulse feeble, irregular, intermitting, and not above 40. She had also suppression of urine for three days †.

A somewhat similar instance may be found in the Journal de Médecine. A man, fifty-five years old, took by mistake a drachm instead of a grain for asthma, and was attacked in an hour with vomiting, giddiness, excessive debility, so that he could not stand, loss of sight, colic, and slow pulse. These effects continued more or less for four days, when the vomiting ceased; and the other symptoms then successively disappeared, the vision, however, remaining depraved for nearly a fortnight ‡.

A very interesting fatal case, which arose from an over-dose administered by a quack doctor, and which became the ground of a criminal trial at London in 1826, is shortly noticed in the same Journal. Six ounces of a strong decoction were taken as a laxative early in the morning. Vomiting, colic, and purging, were the first symptoms; towards the afternoon lethargy supervened; about midnight the colic and purging returned; afterwards general convulsions made their appearance; and a surgeon, who saw the patient at an early hour of the succeeding morning, found him violently convulsed, with the pupils dilated and insensible, and the pulse slow, feeble, and irregular. Coma gradually succeeded, and death took place in twenty-two hours after the poison was swallowed [*].

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* Blackall on Dropsy, p. 173.

† Edin. Med. and Surg. Journ. vii. 149.

‡ *Bidault de Villiers*, Journal de Médecine, Novembre 1817.

This is the only case in which I have seen an account of the appearances in the dead body, and they are related very imperfectly. It is merely said that the external membranes of the brain were much injected with blood, and the inner coat of the stomach red in some parts.

The affections induced by poisoning with digitalis are often much more lasting than the effects of most other vegetable narcotics. Dr Blackall's case is one instance in point, and another no less remarkable in its details is described in Corvisart's Journal. The usual local and constitutional symptoms were produced by a drachm of the powder being taken by mistake; and the slowness of the pulse did not begin to go off for seven days, the affection of the sight not for five days more [†].

The preparations of foxglove are very uncertain in strength. From what I have observed in the course of their medicinal employment, I conceive few powders retain the active properties of the leaves, and even not many tinctures. Two ounces of the tincture of the London College have been taken in two doses with a short interval between them, yet without causing any inconvenience [‡]. This assuredly could not happen with a sound preparation.

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[*] Edin. Med. and Surg. Journ. xxvii. 223, from Morning Chronicle, Oct. 30 and 31, 1826.

[†] Journal de Méd. xl. 193.

[‡] *Williams* in Medical Gazette, i. 744.

CHAPTER XXXVII.

OF POISONING WITH STRYCHNIA, NUX VOMICA, AND FALSE-ANGUSTURA.

The Second Groupe of the Narcotico-Acrids includes a few vegetable poisons that act in a very peculiar manner. They induce violent spasms, exactly like tetanus, and cause death during a fit, probably by suspending the respiration. In this respect they resemble hydrocyanic acid, and the water-hemlock; but they differ from these and all similar poisons in not impairing the sensibility. During the intervals of the fits the sensibility is on the contrary heightened, and the faculties acute.

Death, however, does not always take place by tetanus. In some cases the departure of the convulsions has been followed by a fatal state of general and indescribable exhaustion.

Besides thus acting violently on the nervous system, they also possess local irritant properties; but these are seldom observed on account of the deadliness and quickness of their remote operation on the spine and nerves.

They exert their action by entering the blood-vessels. The dose required to prove fatal is exceedingly small. The organ acted on is chiefly the spinal chord; but sometimes they seem also to act on the heart.

They seldom leave any morbid appearances in the dead body. Like the other causes of death by obstructed respiration, such as drowning and strangling, they produce venous congestion; but this is frequently inconsiderable. Sometimes, however, they leave signs of inflammation in the alimentary canal.

Their energy resides in peculiar alkaloids. There are only two genera included in this groupe, the plants of the genus *Strychnos*, and the *Brucea antidysenterica*.

Several species of *Strychnos* have been examined, namely, the *S. Nux-vomica*, the *S. Sancti Ignatii* or the St Ignatius Bean, the *S. colubrina*, the *S. Tieuté*, which yields an Indian poison the Upas Tieuté, the *S. Guianensis*, and likewise the *S. potatorum* and

S. pseudo-kina; and all have been found to possess the same remarkable properties, except the last two, which are inert.

All of them, except the *S. pseudo-kina*, and probably the *S. potatorum* [*], contain an alkaloid to which their poisonous properties are owing. This is the *Strychnia* or Strychnin, a substance which has lately been made the subject of many experiments by chemists and physiologists.

Of Poisoning with Strychnia.

Strychnia was discovered by *Pelletier* and *Caventou* soon after the discovery of morphia [†]. For an account of the best process for preparing it, the reader may consult a paper by *M. Henry* in the journal quoted below [‡].

Its leading properties are the following. Its crystals when pure are elongated octahedres. It has a most intensely bitter taste, which is perceptible, it is said, when a grain is dissolved in 80 lbs. of water [§]. It is very sparingly soluble in water, but easily soluble in alcohol and the volatile oils. Its alcoholic solution has an alkaline reaction. It forms neutral and crystallizable salts with the acids. In its ordinary form it is turned orange-red by the action of nitric acid; which tint becomes violet-blue on the gradual addition of hydrosulphate of ammonia. The action of nitric acid is owing to the presence of a yellow colouring matter, or of another alkaloid, Brucia, which is also contained in nux vomica, but exists in larger quantity in the False Angustura bark. Pure strychnia is not turned orange-red by nitric acid [‖].

Except Hydrocyanic acid no poison is endowed with such destructive energy as Strychnia. I have killed a dog in two minutes with a sixth part of a grain injected in the form of alcoholic solution into the chest; I have seen a wild-boar killed in the same manner with a third of a grain in ten minutes; and there is little doubt that half a grain thrust into a wound might kill a man in less than a quarter of an hour.—It acts in whatever way it is introduced into the system, but most energetically when injected into a vein.—The symptoms produced are very uniform and striking. The animal becomes agitated and trembles, and is then seized with stiffness and starting of the limbs. These symptoms increase till at length it is attacked with a fit of violent general spasm, in which the head is bent back, the spine stiffened, the limbs extended and rigid, and the respiration checked by the fixing of the chest. The fit is then succeeded by an interval of calm, during which the senses are quite entire or unnaturally acute. But another paroxysm soon sets in, and then another and another, till at length a fit takes place more violent than any before it; and the animal perishes suffocated. The first symptoms appear in 60 or 90 seconds, when the poison is applied to a wound. When it is injected into the pleura, I have known them begin in 45 seconds, and *Pelletier* and *Caventou* have seen them begin in 15 seconds [*]. *M. Bouillaud* has recently found that it has no effect when directly applied to the nerves [†].

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[*] Plantes Usuelles des Braziliens, *Livraison* i. 3.

[†] Ann. de Chim. et de Phys. x. 142.

[‡] Journal de Pharmacie, viii. 401.

[§] Ann. de Chim. et de Phys. x. 153.

[‖] *Pelletier* and *Caventou*, Ibidem, xxvi. 56.

Strychnia has been found by Pelletier and Caventou in four species of the *Strychnos*, the *Nux Vomica*, *Sancti Ignatii*, *Colubrina*, and *Tieuté;* and from the researches of MM. Martius and Herberger on the composition and properties of the American poison Urari, it is also probably contained in the *S. Guianensis* [‡]. Vauquelin could not find it in the *Pseudo-kina.*

Of Poisoning with Nux Vomica.

Tests of Nux Vomica.—Nux Vomica, the most common of the species, is a flat, roundish kernel, hardly an inch in diameter, of a yellowish or greenish brown colour, and covered with short silky hair. In powder it has a dirty greenish gray colour, an intensely bitter taste, and an odour like powder of liquorice. It inflames on burning charcoal, and when treated with nitric acid acquires an orange-red colour, which is destroyed by the addition of protochloride of tin. Its infusion also is turned orange-red by nitric acid, and precipitated grayish white with tincture of galls.

Orfila and *Barruel* have made some experiments on the mode of detecting it in the stomach, and the following is the plan recommended by them. The contents of the stomach, or the powder, if it can be separated, must be boiled in water acidulated with sulphuric acid. The liquid after filtration is neutralized with carbonate of lime, and then evaporated to dryness. The dry mass is then acted on with successive portions of alcohol, and evaporated to the consistence of a thin syrup. The product has an intensely bitter taste, precipitates with ammonia, becomes deep orange-red with nitric acid, and will sometimes deposit crystals of strychnia on standing two or three days *.

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[*] Annales de Chim. et de Phys. xxvi. 44.

[†] Archives Gén. de Méd. xii. 463.

[‡] Buchner's Repertorium für die Pharmacie.

These experiments it is important to remember, because, contrary to what takes place in regard to vegetable poisons generally, nux vomica is very often found in the stomachs of those poisoned with it.

Its Mode of Action and Symptoms in Man.—The poisonous properties of nux vomica are now well known to the vulgar; and in consequence it is occasionally made the instrument of voluntary death, although no poison causes such torture. It is difficult to conceive, on account of its intensely bitter taste, how any one could make it the instrument of murder. But a fact is stated in Rust's Journal, which shows that it may be used for that purpose. At a drinking party one man wagered with another, that if he took a little *cocculus indicus* in beer, he would be compelled to walk home on his head. The wager was taken and the potion drunk; but nux vomica was substituted for the cocculus indicus, itself too a virulent poison; and the man went home and died in convulsions fifteen minutes afterwards †.

Many experiments have been made on animals with nux vomica; but the most accurate are those of *Magendie* and *Delille* read before the French Institute in 1809. The symptoms they remarked were precisely the same with those produced by strychnia. Half a drachm of the powder killed a dog in forty-five minutes, and a grain and a half of the alcoholic extract thrust into a wound killed another in seven minutes. The animals uniformly experienced dreadful fits of tetanic spasm, and were carried off during a paroxysm.

The cause of death appears to be prolonged spasm of the thoracic muscles of respiration. The spasm of these muscles is apparent in the unavailing efforts which the animals make to inspire. The external muscles of the chest may be felt during the fits as hard almost as bone; and, according to an experiment of *Wepfer*, the diaphragm partakes in the spasm of the external muscles*.

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* Archives Gén. de Méd. viii. 22.

† Magazin für die gesammte Heilkunde, xvii. 119.

On account of the singular symptoms of irritation of the spinal chord uncombined with any injury of the brain, this poison is believed to act on the spinal marrow alone. But from some experiments by *Segalas* it appears also to exhaust the irritability of the heart: for in animals he found that organ could not be stimulated to contract after death, and life could not be prolonged by artificial breathing †. A similar observation was made long ago by *Wepfer*, who found the heart motionless and distended with arterial blood in its left cavities ‡; and a case of poisoning in the human subject to the same effect will be presently related. The pulse is always very weak, often wholly suppressed during a paroxysm; and in the case alluded to it was found on dissection pale, flaccid and empty, having been apparently affected with spasm.

Of late poisoning with nux vomica has been common. The most characteristic example yet published is a case related by *Mr Ollier*, of a young woman, who in a fit of melancholy, took between two and three drachms of the powder in water. When the surgeon first saw her, half an hour afterwards, she was quite well. But going away in search of an emetic and returning in ten minutes, he found her in a state of great alarm, with the limbs extended and separated, and the pulse faint and quick. She then had a slight and transient convulsion succeeded by much agitation and anxiety. In a few minutes she had another, and not long afterwards a third, each about two minutes in duration. During these fits, " the whole body was stiffened and straightened, the legs pushed out and forced wide apart; no pulse or breathing could be perceived; the face and hands were livid, and the muscles of the former violently convulsed." In the short intervals between the fits she was quite sensible, had a quick faint pulse, complained of sickness with great thirst, and perspired freely. " A fourth and most violent fit soon succeeded, in which the whole body was extended to the utmost from head to foot. From this she never recovered: She seemed to fall into a state of asphyxia, relaxed her grasp, and dropped her hands on her knees. Her brows, however, remained contracted, her lips drawn apart, salivary foam issued from the corners of the mouth, and the expression of the countenance was altogether most horrific." She died an hour after swallowing the poison *.—A case precisely similar, produced by threepence worth of the powder, and fatal in little more than an hour, is related by *Mr Watt* of Glasgow †.—Occasionally even in such rapid cases there is a little vomiting in the first instance. This was remarked in Mr Watt's case, and also in another described by *MM. Orfila* and *Ollivier* ‡.

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* Cicutæ Aquat. Hist. et Noxæ, p. 295.

† *Magendie*, Journal de Physiol. ii. 361.

‡ Cicutæ Aquat. Hist. et Noxæ, p. 198.

When death does not take place thus suddenly in a fit of spasm, the person continues to be affected for twelve or sixteen hours with similar, but milder paroxysms; and afterwards he may either recover without farther symptoms, or expire in a short time apparently from exhaustion, or suffer an attack of inflammation of the stomach and intestines, which may or may not prove fatal.

M. Jules Cloquet has described a case, where the patient seemed to die of the excessive exhaustion produced by the long-continued and violent spasms. The tetanic fits lasted about twenty-four hours, the sensibility in the intervals being acute. Slight signs of irritation in the stomach succeeded; and death ensued on the fourth morning §.

In the bulletins of the Medical Society of Emulation another case is related, which arose from an over-dose of the alcoholic extract being taken by an old woman who was using it for palsy. She took three grains at once. Violent tetanus was soon produced; and afterwards she had a regular attack of inflammation of the stomach and intestines, which proved fatal in three days.

The last instance to be noticed exemplifies very well the effects of the poison when the quantity is insufficient to cause death. A young woman swallowed purposely a drachm mixed in a glass of wine. In fifteen minutes she was seized with pain and heat in the stomach, burning in the gullet, a sense of rending and weariness in the limbs succeeded by stiffness of the joints, convulsive tremors, tottering in her gait, and at length violent and frequent fits of tetanus. Milk given after the tetanus began excited vomiting. She was farther affected with redness of the gums, inflammation of the tongue, burning thirst, and pain in the stomach. The pulse also became quick, and the skin hot. Next day, though the fits had ceased, the muscles were very sore, especially on motion. The tongue and palate were inflamed, and there was thirst, pain in the stomach, vomiting, colic and diarrhœa. These symptoms, however, abated, and on the fourth day disappeared, leaving her exceedingly weak [*].

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* Lond. Med. Repository, xix. 448.

† Glasgow Medical Journal. August 1830.

‡ Archives Gén. de Méd. viii. 17.

§ Nouv. Journ. de Méd. x. 157.

This and the previous case show clearly the double narcotico-acrid properties of the poison.

With regard to the dose requisite to prove fatal, the smallest fatal dose of the alcoholic extract yet recorded is three grains, which was the quantity taken in the case from the Parisian bulletins; *Hoffmann* mentions a fatal case caused by two fifteen-grain doses of the powder [†]; and in Hufeland's Journal there is another caused by two drachms, which was fatal in two hours [‡]. —A dog has been killed by eight grains of the powder, and a cat by five [§]. It is even said that a dog has been killed by two grains [‖].

It appears probable, from some interesting observations by *Mr Baker* on the medicinal use of nux vomica in Hindostan, that, by the force of habit, the constitution may become to a certain extent accustomed to large doses of this poison, in the same manner as it acquires the power of enduring large doses of opium. The natives of Hindostan often take it morning and evening for many months continuously, beginning with an eighth part of a nut and gradually increasing the dose to an entire nut, or about twenty grains. If it is taken either immediately before or after meals, it never occasions any unpleasant effects; but if this precaution be neglected, spasms are apt to ensue [¶]. As it is found unsafe, however, to increase the dose beyond one nut, and the poison is taken in the form of coarse powder, in which state it must be slowly acted on by the fluids in the stomach, it is probable that the modifying influence of habit is inconsiderable.—The facts mentioned by Mr Baker show that nux vomica is not a cumulative poison.

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[*] *Tacheron*, London Med. Repository, xix. 456.

[†] Med. Rat. System. ii. 175.

[‡] Journ. der Praktischen Heilkunde, iv. 492.

[§] *Hillefeld*, Exp. quædam circa venena. Gott. 1760. Quoted by *Marx*, die Lehre von den Giften, i. ii. 26.

[‖] *Rossi*, Exp. de nonnullis plant. quæ pro venenatis habentur. Pisis, 1762. See *Marx*, i. ii. 29.

[¶] Trans. of the Calcutta Med. and Phys. Soc. i. 138.

Morbid Appearances.—The morbid appearances differ according to the period at which death occurs. In Mr Ollier's case, where death took place in an hour, the appearances were insignificant. The stomach was almost natural, the vessels of the brain somewhat congested, the heart flaccid, empty and pale. In the case in Hufeland's Journal there was general inflammation of the stomach, duodenum and part of the jejunum. In Cloquet's case, a slower one, there was very little appearance of inflammation. In that from the Parisian bulletins, on the contrary, the stomach was highly inflamed, the intestines violet-coloured, in many places easily lacerated and apparently gangrenous. In an interesting dissection of a case, which was quickly fatal,—that related by Orfila and Ollivier, there was found much serous effusion on the surface of the cerebellum, and softening of the whole cortical substance of the brain, but especially of the cerebellum. This is some confirmation of an opinion advanced not long ago in France by Flourens and others, that nux vomica acts particularly on the cerebellum *. Mr Watt remarked in his case (sixty hours, however, after death in summer) softening of the substance of the brain and the lumbar part of the spinal chord.—In Orfila and Ollivier's case the lungs were found much gorged with black fluid blood.

The body appears sometimes to retain for a certain period after death the attitude and expression impressed on it by the convulsions during life. In the instance mentioned by Orfila and Ollivier the muscles immediately after death remained contracted, the head bent back, the arms bent, and the jaws locked. This state may even continue for some hours, so that the body appears to pass into the stage of rigidity which precedes decay, without also passing through the preliminary stage of flaccidity immediately after death. In the case related by Mr Ollier, the body five hours after death "was still as stiff and straight as a statue, so that if one of the hands was moved the whole body moved along with it." This state of rigidity, however, does not invariably occur. On the contrary, in animals the limbs become very flaccid immediately after death; but the usual rigidity supervenes at an early period †.

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* Arch. Gén. de Méd. viii. 18.

† I have not altered the statement as to this point in the former editions. Yet

Treatment.—Little is known of the treatment in this kind of poisoning. But it is of the greatest moment to evacuate the stomach thoroughly, and without loss of time. Hence emetics are useful; but if the stomach-pump is at hand it ought to be resorted to without waiting for the operation of emetics. When nux vomica is taken in powder, which is the most frequent form in which it has been used, it adheres with great obstinacy to the inside of the stomach. Consequently whatever means are employed for evacuating the stomach, they must be continued assiduously for a considerable time. If the patient is not attacked with spasms in two hours, he will generally be safe.

M. Donné of Paris has stated that he has found iodine, bromine, and chlorine to be antidotes for poisoning with the alkaloid of nux vomica, as well as for the other vegetable alkaloids. Iodine, chlorine, and bromine, he says, form with the alkaloids compounds which are not deleterious,—two grains and a-half of the iodide, bromide, and chloride of strychnia, having produced no effect on a dog. Animals which had taken one grain of strychnia, or two grains of veratria, did not sustain any harm, when tincture of iodine was administered immediately afterwards. But the delay of ten minutes in the administration of the antidote rendered it useless. In the compounds formed by these antidotes with the alkaloids, the latter are in a state of chemical union, and not decomposed. Sulphuric acid separates strychnia, for example, from its state of combination with chlorine, iodine, or bromine, and forms sulphate of strychnia, with its usual poisonous qualities [*]. It remains to be proved that the same advantages will be derived from the administration of these antidotes in the instance of poisoning with the crude drug, nux vomica, as in poisoning with its alkaloid.

In general little difficulty will be encountered in recognizing a case of poisoning with nux vomica. *Tetanus* or Locked-jaw is the only disease which produces similar effects. But that disease never proves so quickly fatal as the rapid cases of poi-

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I strongly suspect that authors, who describe the spasm which precedes death to continue as it were into the rigidity which occurs after death, must have observed inaccurately. For in the numerous experiments I have made and witnessed in animals, flaccidity invariably took place at the time of death, and continued for a moderate interval.

[*] Le Globe, vii. 525.—*Août* 19, 1829.

soning with nux vomica; and it never produces the symptoms of irritation observed in the slower cases. Besides, the fits of natural tetanus are almost always slow in being formed; while nux vomica brings on perfect fits in an hour or less. It is right to remember, however, that nux vomica may be given in small doses, frequently repeated, and gradually increased, so as to imitate exactly the phenomena of tetanus from natural causes. Medical men will be at no loss to discover, on reflection, how the preparations of this drug may be rendered formidable secret poisons.

Of Poisoning with the St Ignatius Bean and Upas Tieuté.

The *Strychnos Sancti Ignatii*, or St Ignatius Bean, contains about three times as much Strychnia as nux vomica, namely, from twelve to eighteen parts in the 1000. It is very energetic. *Dr Hopf* has mentioned an instance of a man, who was attacked with tetanus of several hours' duration after taking the powder of half a bean in brandy, and who seems to have made a narrow escape [*].

The *Strychnos Tieuté* is the plant which yields the Upas Tieuté, one of the Javanese poisons. This substance has been analyzed by *Pelletier* and *Caventou*, and found to contain Strychnia [†]. From the experiments of *Magendie* and *Delille*, the Upas Tieuté appears to be almost as energetic as Strychnia itself [‡]. *Mayer* found that the bark of the plant which yields it, when applied in the dose of fifty grains to a wound, killed a rabbit in two hours and a-half [§].—*Dr Darwin* has given an account of its effects on the Javanese criminals, who used formerly to be executed by darts poisoned with the Tieuté. The account quoted by him is not very authentic; yet it accords precisely with what would be expected from the known properties of the poison. He says, that a few minutes after the criminals are wounded with the instrument of the executioner, they tremble violently, utter piercing cries, and perish amidst frightful convulsions in ten or fifteen minutes [||].

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[*] *Henke's* Zeitschrift für die Staatsarzneikunde, ii. 169.

[†] Ann. de Chim. et de Phys. xxvi. 44.

[‡] *Orfila*, Toxicol. Gén. ii. 364.

[§] Journal de Chim. Méd. vi. 593.

[||] Botanic Garden, ii. 256.

Of Poisoning with False Angustura Bark.

Besides these poisons of the genus Strychnos, the present groupe comprehends another, supposed to be derived from a plant of a different family, the *Brucea antidysenterica*, which causes symptoms of the same kind, and owes its power to an analogous principal, Brucia.

A species of bark, commonly called the False Angustura bark, was introduced by mistake into Europe instead of the true Angustura, or bark of the *Galipea febrifuga*. It was long supposed to be the bark of the *Brucea antidysenterica*; but the latest inquiries seem rather to point at its being the produce of a species of *Strychnos*, and perhaps of the familiar species *S. nux-vomica*. Be this as it may, False Angustura bark is a poison of great energy. It gave rise to so many fatal accidents soon after its introduction, that in some countries on the continent all the stores of Angustura were ordered to be burnt.

According to *Andral*, Brucia is twenty-four times less powerful than strychnia[*]; but the bark itself is as strong nearly as nux vomica, for Orfila found that eight grains killed a dog in less than two hours[†].

The symptoms it induces are almost the same as those caused by nux vomica. They are minutely detailed in a paper by *Professor Emmert* of Bern[‡]. It appears that during the intervals of the fits the sensibility is remarkably acute: A boy who fell a victim to it implored his physician not to touch him, as he was immediately thrown into a fit.—*Professor Marc* of Paris was once violently affected by this poison, which he took by mistake for the true Angustura to cure ague. He took it in the form of infusion, and the dose was only three quarters of a liqueur-glassful; yet he was seized with nausea, pain in the stomach, a sense of fulness in the head, giddiness, ringing in the ears, and obscurity of vision, followed by stiffness of the limbs, great pain on every attempt at motion, locked-jaw, and impossibility of articulating. These symptoms continued two hours; and abated under the use of ether and laudanum[§].

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[*] *Magendie*, Journ. de Physiologie, iii. 267.

[†] Toxicol. Générale, ii. 377.

[‡] Ueber die giftige Wirkungen der unächten Angustura.—*Hufeland's* Journal, xl. iii. 68.

[§] Journal de Pharmacie, ii. 507.

Some very interesting experiments were made by *Emmert* with this poison to show that it acts on the spine directly, and not on that organ through the medium of the brain. If an animal be poisoned by inserting the extract of False Angustura bark into its hind-leg after the spinal chord has been severed at the loins, the hind-legs as well as the fore-legs are thrown into a state of spasm; or if the medulla oblongata be cut across and respiration maintained artificially, the usual symptoms are produced over the whole body by the administration of it internally or externally,—the only material difference being that they commence more slowly, and that a larger dose is required to produce them, than when the medulla is not injured. On the other hand, when the spinal chord is suddenly destroyed after the symptoms have begun, they cease instantaneously, although the circulation goes on for some minutes *.

The true Angustura bark has a finer texture than the other, and is darker coloured, and less bitter. The ferrocyanate of potass causes in a muriatic infusion of the false bark a precipitate, which is first green and then becomes blue; and the same reagent converts into blue the reddish powder which lines the bark. No such effect is produced on the true Augustura bark, as it does not, like the other, contain oxide of iron. Other differences are accurately detailed in the Edinburgh Medical and Surgical Journal, Vol. xii.

With the preceding poisons Orfila has arranged also some poisons used by the American Indians, the Woorara, Ticunas, and Curare; but, as in Europe they are mere objects of curiosity, it is unnecessary to mention them here. Their effects are described in *Mr Brodie's* papers in the Philosophical Transactions for 1811–12, in *Orfila's* Toxicology, in *Magendie's* Memoir on Absorption, and in *Fontana's* Traité des Poisons. But the best account perhaps is that by *Emmert*, published in 1818. They produce not convulsions or spasm of the muscles, but on the contrary sudden paralysis, and probably occasion death in this way by suspending the respiration. According to Emmert's experiments the spine only is acted on, and not the brain also †.

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* Meckel's Archiv fur Anatomie und Physiologie, i. 1.

† Ueber das Amerikanische Pfeilgift. *Meckel's* Archiv für Anatomie und Physiologie, iv. 65.

CHAPTER XXXVIII.

OF POISONING WITH CAMPHOR AND COCCULUS INDICUS.

The Third groupe of the narcotico-acrids resemble strychnia in their action so far, that they produce in large doses convulsions of the tetanic kind. But they differ considerably by producing at the same time impaired sensibility or sopor. They are Camphor, Cocculus Indicus, its active principle Picrotoxin, the Coriaria myrtifolia, and the Upas Antiar, a Javanese poison.

Of Poisoning with Camphor.

Camphor dissolved in oil soon causes in dogs paroxysms of tetanic spasm. At first the senses are entire in the intervals; but by degrees they become duller, till at length a state of deep sopor is established, with noisy and laborious breathing, and expiration of camphrous fumes; and in this state the animal soon perishes. A solution of twenty grains in olive oil will kill a dog in less than ten minutes when injected into the jugular vein. When camphor is given to dogs in fragments, it does not give rise to convulsions, but kills them more slowly by inducing inflammation of the alimentary canal. These are the results of numerous experiments by *Orfila* [*].

They are confirmed by others performed more lately by *Scudery* of Messina; but this experimentalist likewise remarked, that the convulsions were attended with a singular kind of delirium, which made the animals run up and down without apparent cause, as if they were maniacal. He also found the urinary organs generally affected, and for the most part with strangury [†].

Symptoms in Man.—The symptoms caused by camphor in man have not been often observed; but so far as they have been witnessed, they establish its claim to be considered a narcotic and acrid poison. Its effects appear to be singularly uncertain: At least they are very discrepant; and the reason for this is not apparent.

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[*] Toxicol. Générale, ii. 400.

[†] Annali Univ. di Med. xxxvi. 102.

Its narcotic effects are well exemplified in an account given by Mr Alexander from personal experience, and by Dr Edwards of Paris, as they occurred in a patient of his who received a camphor clyster.

Mr Alexander, in the course of his experiments on his own person with various drugs, was nearly killed by this poison, and has left the best account yet published of its effects in dangerous doses on man. After having found by a previous experiment, that a scruple did not cause any particular symptom, he swallowed in one dose two scruples mixed with syrup of roses. In the course of twenty minutes he became languid and listless, and in an hour giddy, confused, and forgetful. All objects quivered before his eyes, and a tumult of undigested ideas floated through his mind. At length he lost all consciousness, during which he was attacked with strong convulsive fits and maniacal frenzy. These alarming symptoms were dispelled, on Dr Monro, who had been sent for, accidentally discovering the subject of his patient's experimental researches, and administering an emetic. But a variety of singular mental affections continued for some time after. The emetic brought away almost the whole camphor which had been swallowed three hours before *.

In *Dr Edwards's* patient, the symptoms were excited by an injection containing half a drachm of camphor. In a few minutes he felt a camphrous taste, which was followed by indescribable uneasiness. On then going down stairs for assistance, he was astonished to feel his body so light that he seemed to himself to skim along the floor almost without touching it. He afterwards began to stagger, his face became pale, he felt chilly, and was attacked with a sense of numbness in the scalp. After taking a glass of wine which he asked for, he became gradually better; but for some time his mind was singularly affected. He felt anxious, without thinking himself in danger; he shed tears, but could not tell why; they flowed in fact involuntarily. For twenty-four hours his breath exhaled a camphrous odour †.

Hoffmann has related a case analogous to those of Alexander and Edwards. The dose was two scruples taken in oil; the symptoms vertigo, chilliness, anxiety, delirium, and somnolency [*].

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* Experimental Essays, 128.

† Orfila, Toxic. Gén. ii. 406.

These cases would seem to indicate very considerable activity; yet there can be little doubt that even larger doses have been at times taken with much less effect. Thus, from an account given by *Dr Eickhorn* of New Orleans of its operation on himself when incautiously swallowed to the amount of two drachms in frequent small doses within three hours, it would appear that the only result was great heat, palpitation, hurried pulse, and pleasant intoxication, then moisture of the skin, next profound sleep for some hours, attended with excessive sweating, and finally no ultimate ill consequence except great debility [†].

Professor Wendt of Breslau has related an instance, which proves the irritant action of camphor on man, and likewise the uncertainty of the dose required to act deleteriously. In the case of Mr Alexander, two scruples would in all probability have proved fatal, had they not been discharged in time by vomiting. In the case now to be noticed, 160 grains were taken in a state of solution in alcohol, and were not vomited; yet the individual recovered. He was a drunkard, who took four ounces of camphorated spirit prescribed for him as an embrocation. Soon afterwards he was attacked with fever, burning heat of the skin, anxiety, burning pain in the stomach, giddiness, flushed face, dimness of sight, sparks before the eyes, and some delirium. He soon got well under the use of almond oil and vinegar, but did not vomit [‡].

Morbid Appearances.—The morbid appearances caused by camphor have not, so far as I know, been witnessed in man. In dogs examined immediately after death the heart is no longer contractile, and its left cavities contain arterial blood of a reddish-brown colour. When the poison has been given in fragments, it leaves marks of inflammation in the stomach and intestines. *Orfila* found these organs much inflamed in such circumstances [§]. *Scudery* found the membranes of the brain much injected and the brain itself sometimes softened; the inner membrane of the stomach either very red, or checkered with black, gangrenous-like spots of the size of millet-seeds; the duodenum in the same state; the ureters, urethra, and spermatic cords inflamed; and every organ in the body, even the brain, giving out a strong odour of camphor [*].

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[*] Orfila, Toxic. Gén. ii. 407.

[†] London Med. Gazette, xi. 772. From American Journal of Med. Science.

[‡] Rust's Magazin für die gesammte Heilkunde, xxv. 88.

[§] Toxicol. Gén. ii. 400.

Of Poisoning with Cocculus Indicus.

The *Menispermum cocculus*, or *Cocculus suberosus*, is a creeping plant which grows in the island of Ceylon, on the Malabar coast, and in other parts of the East Indies. Its fruit, which is the only part of the plant hitherto particularly examined, is like a large, rough, black pea, and is commonly known in the shops by the name of Cocculus Indicus. It has a rough, ligneous pericarp, enclosing a pale grayish-yellow, brittle kernel of a very strong and permanent bitter taste. The medical jurist should make himself well acquainted with its external characters, because, besides being occasionally used in medicine, it is a familiar poison for destroying fish, and has also been extensively used by brewers as a substitute for hops,—an adulteration which is prohibited in Britain by severe statutes. It has been analyzed by *M. Boullay* of Paris [†], who found in it besides other matters, a peculiar principle termed Picrotoxin: This principle constitutes, according to Boullay, about a fifth part of the kernel; according to *Nees von Esenbeck*, only a hundredth part [‡]: and my own experiments agree with the results of the latter. It is moderately soluble in water, and crystallizes readily from a hot acidulous watery solution. It is more soluble in hot alcohol, from which it crystallizes in granular masses. Ten grains of it killed a dog in twenty-five minutes in the second paroxysm of tetanus.

The seeds themselves occasion vomiting soon after they are swallowed; so that animals may often swallow them, if not without injury, at all events without danger. But if the gullet is tied, the animal soon begins to stagger; the eye acquires a peculiar haggard expression, which is the sure forerunner of a tetanic paroxysm; and the second, third, or fourth fit commonly proves fatal. Three or four drachms will kill a dog when introduced into the stomach; less will suffice when it is applied to a wound; and still less when it is injected into a vein *. *Wepfer* has related a good experiment, from which he infers that the Cocculus indicus acts by exhausting the irritability of the heart. In the intervals of the fits the pulse could not be felt; and on opening the chest immediately after death he found the heart motionless and all its cavities distended †. *Orfila* also sometimes found the heart motionless, and its left cavities filled with reddish-brown blood ‡.

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[*] Annali, &c. xxxvi. 106.

[†] Ann. de Chimie, lxxx. 109.

[‡] *Buchner's* Repertorium für die Pharmacie, xxiv. 55.

This poison does not seem to possess distinct acrid properties in regard to animals. *M. Goupil* indeed found that it produced symptoms of irritation §, but Orfila could not observe any such effect. According to Goupil it possesses the singular property of communicating to the flesh of animals, more particularly of fish, that have been killed with it, some of the poisonous qualities with which it is itself endowed. The accuracy of this statement may be doubted, the alleged fact being contrary to analogy.

Symptoms in Man.—Although it is well known that malt liquors have often been adulterated with Cocculus indicus for the purpose of economizing hops, cases of poisoning in the human subject are rare, because the quantity required to communicate the due degree of bitterness is small. *Professor Bernt* has shortly noticed a set of cases, which arose in consequence of an idiot having seasoned soup with it by mistake. Nine people were taken ill with sickness, vomiting, pain in the stomach and bowels; and one died in twelve days ||. The symptoms under which this person died are not stated; but the account of the accident sent to Bernt imputed death to the poison, which is improbable, considering the length of the interval before death.

In the same groupe with camphor and Cocculus indicus Orfila has arranged the *Upas antiar*, a Javanese poison. This poison is a very bitter milky juice or extract, which is known in Europe only as an article of curiosity. It has been sometimes confounded with the Upas Tieuté. From the experiments of *MM. Magendie* and *Delille* ¶, as well as from those of *Mr Bro-*

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* *Orfila*, Toxicol. Gén. ii. 411.

† Cicut. Aquat. Hist. p. 186.

‡ Toxicol. Gén. ii. 412, 414.

§ Ibidem, ii. 410.

|| Beiträge zur Gerichtl. Arzneikunde, iii. 241.

¶ *Orfila*, Toxicol. Gén. ii. 396.

die * and of *Emmert* † it appears to act in the same manner, and to produce the same effects, as camphor and Cocculus indicus. In small doses it acts as an irritant; in large doses it causes convulsions and coma.

It is here noticed principally because it is one of the poisons which acts violently on the heart. If the body of an animal be examined immediately after death from the Upas antiar, the heart is found to have lost its irritability, and the left ventricle to contain florid blood: *Schnell* found, that, like many other active poisons, it has no effect when applied to the divided end of a nerve ‡.

The *Coriaria myrtifolia* also possesses the properties of the present groupe, and is sufficiently important from its energy, and its occasional injurious effects on man, to claim some notice here.

Its toxicological effects have been recently investigated by *Professor Mayer* of Bonn, who found that it excites in most animals violent fits of tetanus, giving place to apoplectic coma; and that in the dead body the brain is seen gorged with blood, the blood in the heart and great vessels fluid, the heart not irritable immediately after death, and the inner membrane of the stomach yellowish and shrivelled. A drachm of the extract of the juice killed a cat in two hours when swallowed; half a drachm applied to a wound killed another in eighty-five minutes; and six grains in the same way killed a kitten in three hours and a-half. A drachm swallowed by a young dog killed it in two hours and a-half. Ten grains of the extract of the infusion applied to a wound killed a kitten in six hours; and three grains another in three hours. A buzzard was killed in three quarters of an hour by half a drachm of the extract of the juice. Frogs are also soon killed by it. Rabbits, it is remarkable, are scarcely affected by this poison, either administered internally, or applied to a wound,—a drachm in the former way, and half as much in the latter, having produced no effect at all. A grain, however, injected into the jugular vein occasioned in about five hours a single convulsive paroxysm, which proved immediately fatal §.

Instances of poisoning with this substance have occurred in taken in various parts of the Continent with senna, which it is employed to adulterate. *Sauvages* has recorded two cases of death occasioned by the berries. In one, a child, death took place within a day under symptoms like epileptic convulsions; and in the other, an adult, who swallowed only fifteen berries, convulsions, coma, and lividity of the face were produced, ending fatally the same evening, though the greater part of the berries were discharged by emetics [*]. In recent French journals various similar cases are recorded. *M. Fée* describes five cases, one of them fatal. In this instance, a male adult, death occurred within four hours after he took an infusion of senna adulterated with the coriaria; and the symptoms were violent convulsions, locked-jaw and colic [†]. *M. Roux* has noticed a great number of cases in the fullest paper yet published on its effects on man, and gives the details of three which came under his own notice, and of which one proved fatal. In the fatal case, that of a child three years and a-half old, who took between eighty and a hundred berries, the symptoms were heat and pricking of the tongue, sparkling and rolling of the eyes, loss of voice, locked-jaw, and convulsions recurring in occasional fits of eight or ten minutes in duration. Death ensued in sixteen hours and a-half [‡]. Roux refers also among other instances to those of no fewer than ten soldiers, who were attacked at the same time in consequence of eating the berries, and of whom two died. In Roux's fatal case there was injection of the membranes of the brain, and no other particular appearance; in that mentioned by Fée, there was inflammation of the stomach and bowels; and in one of Sauvages's cases no morbid appearance at all was discovered.

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* Philos. Trans. 1811.

† Diss. Inaug. sistens historiam Veneni Upas antiar, &c. Tubingæ, 1815.

‡ Diss. Inaug. de Veneno Upas antiar, Tubingæ, 1815, p. 27.

§ *Buchner's* Repertorium, xxxi., and *Hufeland's* Journal, lxviii. iv. 43.

Considering these very pointed proofs of the poisonous qualities of the Coriaria, it is not a little singular that doubts have lately arisen whether it is a poison at all. *Peschier* of Geneva says he has ascertained that tanners, who use it in their trade on account of the powerful astringency of the leaves, also take it internally for gleet, and that he gave a decoction of an ounce to chickens, dogs, and men, without witnessing any ill effect [§].

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[*] Mém. de l'Acad. des Sciences, 1739, p. 47.

[†] Journal de Chim. Méd. iv. 528.

[‡] London Medical and Physical Journal, April 1829.

[§] Mémoires de la Soc. de Phys. et d'Hist. Nat. de Génève, v. 194.

CHAPTER XXXIX.

OF THE POISONOUS FUNGI.

A FOURTH groupe of poisons possessing narcotico-acrid properties, includes the poisonous *Fungi* or Mushrooms.

Accidents arising from the deadly Fungi being mistaken for eatable mushrooms are common on the continent, and especially in France. They are by no means infrequent, too, in Britain; but they are much less frequent than abroad, because the epicure's catalogue of mushrooms in this country contains only three species, whose characters are too distinct to be mistaken by a person of ordinary skill; while abroad a great variety of them have found their way to the table, many of which are not only liable to be confounded with poisonous species, but are even also themselves of doubtful quality.

The present subject cannot be thoroughly studied without a knowledge of the appearance and characters of all the fungi which have been ascertained to be esculent, as well as of those which are known to be deleterious. This information, however, I cannot pretend to communicate, as it would lead to great details. In what follows, therefore, a simple list will be given of the two classes, with references to the proper sources for minute descriptions of them, and some general observations on the effects of the poisonous species.

List of the wholesome and poisonous Fungi.—The only good account yet published of the innocent or eatable fungi of Great Britain is contained in an elaborate essay on the subject by *Dr Greville* of this place. He enumerates no fewer than twenty-six different species, which grow abundantly in our woods and fields, and which, although most of them utterly neglected in this country, are all considered eatable, and many of them delicate abroad. They are the following: *Tuber cibarium*, or common truffle; *T. moschatum* and *T. album*, two species of analogous qualities; *Amanita cæsarea* or *aurantiaca*, the Oronge of the French, a species which is often confounded by the ignorant with a very poisonous one, the *A. muscaria*, or *pseudo* room of meadows; *A. edulis*, or white caps; *A. oreades*, or Scotch bonnets; *A. odorus; A. eburneus; A. ulmarius; A. ostreatus; A. violaceus; A. deliciosus; A. piperatus;* and *A. acris; Boletus edulis;* and *B. scaber; Fistulina hepatica; Hydnum repandum; Morchella esculenta*, the common morelle; *Helvella mitra*, and *H. leucophæa.* Of these the *Agaricus acris* and *A. piperatus* are probably unwholesome; and the *Amanita cæsarea* is very rare in this country, if indeed it is indigenous at all. The *A. muscaria*, with which it is apt to be confounded, is common enough. The species to which our cooks confine their attention are the *Tuber cibarius* or truffle, the *Agaricus campestris*, or common mushroom, and the *Morchella esculenta*, or morelle. The *Agaricus edulis* is also to be met with in some markets, but is not in general use [*].

The best description of the poisonous species is to be found in Orfila's Toxicology. He enumerates the *Amanita muscaria, alba, citrina,* and *viridis;* the *Hypophyllum maculatum, albocitrinum, tricuspidatum, sanguineum, crux-melitense, pudibundum* and *pellitum;* the *Agaricus necator, acris, piperatus, pyrogalus, stypticus, annularis,* and *urens* [†]. To these may be added the *Agaricus semiglobatus*, on the authority of *Messrs Brande* and *Sowerby* [‡], and also the *A. campanulatus* [§]. It is highly probable that many other species are also injurious.

Circumstances which modify their qualities.—The qualities of the fungi as articles of food are liable to considerable variety. Some, which are in general eaten with safety, occasionally become hurtful; and some of the poisonous kinds may under certain circumstances become inert, or even esculent. But the causes which regulate these variations are not well ascertained.

It has been thought by some that most fungi become safe when they have been dried [||]; and there may be some truth in this remark, as their poisonous qualities appear to depend in part on a volatile principle. But it is by no means universally truffles. He was seized with headach, a sense of weight in the stomach, and faintness; and he lived only a few hours *.

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[*] On the Esculent Fungi of Great Britain. *Mem. Wernerian Society*, iv. 339.

[†] Toxicol. Gén. 417–428.

[‡] London Med. and Phys. Journal, iii. 41.

[§] Ibid. xxxvi. 451.

[||] *Foderé*, Médecine-Légale, iv. 61. and 58.

Lastly, it is probable from a singular set of cases to be related presently, that, contrary to what some botanists have alleged, the best mushrooms when taken in large quantity, and for a considerable length of time, are deleterious to every one.

Foderé †, *Orfila* ‡, *Decandolle* §, and *Greville* || have laid down general directions for distinguishing the esculent from the poisonous varieties; but it is extremely questionable whether their rules are always safe; and certainly they are not always accurate, as they would exclude many species in common use on the continent. It appears that most fungi which have a warty cap, more especially fragments of membrane adhering to their upper surface, are poisonous. Heavy fungi, which have an unpleasant odour, especially if they emerge from a *vulva* or bag, are also generally hurtful. Of those which grow in woods and shady places a few are esculent, but most are unwholesome; and if moist on the surface they should be avoided. All those which grow in tufts or clusters from the trunks or stumps of trees ought likewise to be shunned. A sure test of a poisonous fungus is an astringent, styptic taste, and perhaps also a disagreeable, but certainly a pungent odour. Some fungi possessing these properties have indeed found their way to the epicure's table; but they are of very questionable quality. Those whose substance becomes blue soon after being cut are invariably poisonous. Agarics of an orange or rose-red colour, and Boleti which are coriaceous or corky in texture, or which have a membranous collar round the stem, are also unsafe: but these rules are not universally applicable in other genera. Even the esculent mushrooms, if partially devoured and abandoned by insects, are avoided by some as having in all probability acquired injurious qualities which they do not usually possess; but this test I have often disregarded.—These rules for knowing deleterious fungi seem to rest on fact and experience; but they will not enable the collector to recognize every poisonous spe-

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* Edin. Med. and Surg. Journal, ix. 379.

† Médecine Légale, iv. 55, *et passim*.

‡ Toxicol. Gén. ii. 445.

§ Essai sur les Propriétés Médicales des Plantes, 320.

|| Mem. Wernerian Soc. iv. 342.

cies. The general rules laid down for distinguishing wholesome fungi are not so well-founded, and therefore it appears unnecessary to specify them.

On the Poisonous Principle of the Fungi.—Few attempts have been hitherto made to discover by chemical analysis the principles on which the effects of the poisonous mushrooms depend. *M. Braconnot* analyzed a considerable number both of the esculent and poisonous species, and found in some a saccharine matter, in others an acrid resin, in others an acrid volatile principle, and in all a spongy matter, which forms the basis of them, and which he has denominated Fungin [*]. The last ingredient is innocuous, and it does not appear that M. Braconnot could trace the peculiar powers of the fungi to any of the acrid principles. More lately the subject was resumed by *M. Letellier*, who says he found in some of them one, in others two poisonous principles. One of the principles is an acrid matter so very fugacious, that it disappears when the plant is either dried, or boiled, or macerated in weak acids, alkalis, or alcohol. To this principle he says are owing the irritant properties of some fungi. The other principle is more fixed, as it resists drying, boiling, and the action of weak alkalis and acids. It is soluble in water, has neither smell nor taste, and forms crystallizable salts with acids; but he did not succeed in separating it in a state of purity. To this principle he attributes the narcotic properties of some fungi. He found it in the *Amanita bulbosa*, *muscaria*, and *verna*; and he therefore proposed to call it Amanitine. Its effects on animals appear to resemble considerably those of opium [†].

Of the Symptoms produced in Man by the Poisonous Fungi.—The mode of action of the poisonous fungi has not been particularly examined; but the experiments of *Paulet* long ago established that they are poisonous to animals as well as to man [‡].

The symptoms produced by them in man are endless in variety, and fully substantiate the propriety of arranging them in the class of narcotico-acrid poisons. Sometimes they produce narcotic symptoms alone, sometimes only symptoms of irritation, but much more commonly both together. It is likewise not improbable, that fungi, even though not belonging to the varieties commonly acknowledged as poisons, induce, when taken for a considerable length of time, a peculiar depraved state of the constitution, leading to external suppuration and gangrene. Each of these statements will now be illustrated by a few examples.

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[*] Ann. de Chimie, lxxix. 265; lxxx. 272; lxxxvii. 237.

[†] Archives Gén. de Méd. xi. 94.

[‡] Traité des Champignons.—Also Mém. sur les Champignons coëffés. Mem. de la Soc. Roy. de Méd. i. 431.

The following is a good instance of pure narcotism. A man gathered in Hyde Park a considerable number of the *Agaricus campanulatus*, which he mistook for the *A. campestris*, stewed them, and proceeded to eat them; but before ending his repast, and not above ten minutes after he began it, he was suddenly attacked with dimness of vision, giddiness, debility, trembling and loss of recollection. In a short time he recovered so far as to be able to go in search of assistance. But he had hardly walked 250 yards when his memory again failed him, and he lost his way. His countenance expressed anxiety, he reeled about, and could hardly articulate. The pulse was slow and feeble. He soon became so drowsy that he could be kept awake only by constant dragging. Vomiting was then produced by means of the sulphate of zinc; the drowsiness gradually went off; and next day he complained merely of languor and weakness *.

In the next set of cases the symptoms were those of almost pure irritation. Several French soldiers in Russia ate a large quantity of the *Amanita muscaria*, which they had mistaken for the *Amanita cæsarea*. Some were not taken ill for six hours and upwards. Four of them, who were very powerful men, thought themselves safe, because while their companions were already suffering, they themselves felt perfectly well; and they refused to take emetics. In the evening, however, they began to complain of anxiety, a sense of suffocation, frequent fainting, burning thirst, and violent gripes. The pulse became small and irregular, and the body bedewed with cold sweat; the lineaments of the countenance were singularly changed, the nose and lips acquiring a violet tint; they trembled much; the belly swelled, and a profuse fetid diarrhœa supervened. The extremities soon became livid and cold, and the pain of the abdomen intense; delirium ensued; and all the four died*.

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* London Med. and Phys. Journal, xxxvi. 451.

Such cases, however, do not appear to be very common; and much more generally the symptoms of poisoning with the fungi present a well-marked conjunction of deep narcotism and violent irritation, as the instances now to be mentioned will show.

Besides the four soldiers whose cases have just been described, several of their comrades were severely affected, but recovered. Two of these had weak pulse, tense and painful belly, partial cold sweats, fetid breath and stools. In the afternoon they became delirious, then comatose, and the coma lasted twenty-four hours.

A man, his wife, and three children, ate to dinner carp which had been stewed by mistake with the *Amanita citrina.* The wife, the servant, and one of the children had vomiting, followed by deep sopor; but they recovered. The husband had true and violent cholera, but recovered also. The two other children became profoundly lethargic and comatose, emetics had no effect, and death soon ensued without any other remarkable symptom. The individuals who recovered were not completely well till three weeks after the fatal repast†. This set of cases shows the tendency of the poisonous fungi to cause in one person pure irritation, and in another pure narcotism.

The last set of cases to be mentioned were produced by the *Hypophyllum sanguineum*, a small conical fungus of a mouse colour, that grows on a slender stem, and is well known to children in Scotland by the name of *puddock-stool.* This species seems to cause convulsions as well as sopor. A family of six persons, four of whom were children, ate about two pounds of it dressed with butter. The incipient symptoms were pain in the pit of the stomach, a sense of impending suffocation, and violent efforts to vomit; which symptoms did not commence in any of them till about twelve hours after the poisonous meal, in one not till twenty hours, and in another not till nearly thirty hours. One of the children, seven years of age, had acute pain of the belly, which soon swelled enormously; afterwards he fell into a state of lethargic sleep, but continued to cry; about twenty-four hours after eating the fungi the limbs became affected with permanent spasms and convulsive fits; and in no long time he expired in a tetanic paroxysm. Another of the children, ten years old, perished nearly in the same manner, but with convulsions of greater violence. The mother had frequent bloody stools and vomiting; the skin became yellow; the muscles of the abdomen were contracted spasmodically, so that the navel was drawn towards the spine; profound lethargy and general coldness supervened; and she too died about thirty-six hours after eating the fungus. A third child, after slight symptoms of amendment had shown themselves, became worse, and died on the third day with trembling, delirium, and convulsions. This patient, who had taken very little of the poison, was not attacked till about thirty hours after the meal. The fourth child, after precursory symptoms like those of the rest, became delirious, and had an attack of colic and inflammation of the bowels, without diarrhœa; but he eventually recovered. The father had a severe attack of dysentery for three days, and remained five days speechless. For a long time afterwards he had occasional bloody diarrhœa. He eventually recovered; but even for an entire year his health continued to suffer [*]. The cases now mentioned illustrate clearly the simultaneous occurrence of narcotic and irritant symptoms in the same individuals.

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* Corvisart's Journ. de Méd. xxxi. 323, from *Vadrot.* Diss. Inaug. sur l'empoisonnement par les Champignons.

† *Orfila,* Toxicol. Gén. ii. 433.

A striking circumstance in respect to the symptoms of poisoning with the fungi, is the great difference in the interval which elapses between the time of eating, and that of their commencement. In the first case the symptoms appear to have commenced in a few minutes; but, on the contrary, an interval of twelve hours is common; and *Gmelin* has quoted a set of cases, seventeen in number, in which, as in one of those related by *Picco*, the interval is said to have been a day and a half [†]. The tardiness of the approach of the symptoms is owing to the indigestibility of most of the fungi. Their indigestibility is in fact so great, that portions of them have been discharged by vomiting so late as fifty-two hours after they were swallowed [‡].

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[*] *Picco*—Mém. de la Soc. Roy. de Méd. 1780-81, p. 355.

[†] Geschichte der Pflanzengifte, 639.

[‡] *Aymen* in Hist. de la Soc. Roy. de Méd. i. 344.

Another circumstance worthy of particular notice is the great durability of the symptoms. Even the purely narcotic effects of some fungi have been known to last above two days. In the instance just alluded to, the vomiting of the poison was the first thing that interrupted a state of deep lethargy which had prevailed for fifty-two hours. The symptoms of irritation, after their violence has been mitigated, may continue, as in the instances quoted from Orfila, for about three weeks.

It was stated above that some people are apt to suffer unpleasant effects from eating even the best and safest of the esculent mushrooms. These effects, which depend on idiosyncrasy, are confined chiefly to an attack of vomiting and purging, followed by more or less indigestion. Some persons have been similarly affected even by the small portion of the juice of mushrooms which is contained in an ordinary ketchup seasoning. This accident, however, may very well be often unconnected with idiosyncrasy, as I have seen those who gather mushrooms near Edinburgh, for the purpose of making ketchup, picking up every fungus that came in their way.

There is some reason for suspecting that even the best mushrooms, when taken as a principal article of food for a considerable length of time, will prove injurious, and that they then induce a peculiar depraved habit, which leads to external suppuration and gangrene. The only cases which have hitherto appeared in support of this statement were lately published in Rust's Journal. A family, consisting of the mother and four children, were seized with a kind of tertian fever, and an eruption, on various parts of the body, of abscesses which discharged a thin, ill-conditioned pus, passed rapidly into spreading gangrene, and proved fatal to the mother and one of the children. No other cause could be discovered to account for so extraordinary a conjunction of symptoms in so many individuals, except that for two months they had lived almost entirely on mushrooms; and the probability of this being really the cause was strengthened by the fact, that the father, who slept always with his family, and who alone escaped, lived on ordinary food at a place where he worked not far off *. In opposition, however, to the natural inference from this narrative, some have believed, that mushrooms may be safely eaten to a

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* Rust's Magazin für die gesammte Heilkunde, xvi. 115.

large amount and for a long time, provided they be used raw. A botanist of Persoon's acquaintance, while studying the cryptogamous plants in the vicinity of Nuremberg, says he found that the peasants ate them in large quantities as their daily food: and in imitation of their custom, he ate for several weeks nothing but bread and raw mushrooms; yet at the end he experienced an increase rather than a diminution of strength, and enjoyed perfect health. He adds that they lose their good qualities by cooking; but he has supplied no facts in support of that statement [*].

Of the Morbid Appearances.—The morbid appearances left in the bodies of persons poisoned by the deleterious fungi have been but imperfectly collected.

The body is in general very livid; and the blood fluid; so much so sometimes that it flows from the natural openings in the dead body [†]. In general the abdomen is distended with fetid air; which indeed is usually present during life. The stomach and small intestines of the four French soldiers (p. 820,) presented the appearance of inflammation, passing in some places to gangrene. In two of them especially, the stomach was gangrenous in many places and far advanced in putrefaction. The same appearances were found in Picco's cases. In these there was also an excessive enlargement of the liver. The lungs have sometimes been found gorged or even inflamed. The vessels of the brain are also sometimes very turgid. They were particularly so in a case related by Dr Beck, where death was occasioned in seven hours by an infusion of the *Amanita muscaria* in milk. The whole sinuses of the dura mater, as well as the arteries, were enormously distended with blood; the arachnoid and pia mater were of a scarlet colour; the vessels of the membrane between the convolutions, together with the plexus choroides, were also excessively gorged; and the substance of the brain was red. Lastly, a clot of blood as big as a bean was found in the cerebellum [‡].—The stomach, unless there has been vomiting or diarrhœa, will usually contain fragments of the poison, if it has not been taken in a state of minute division; and this evidence of the cause of death may be obtained even although the individual survived two days or upwards. Sometimes the fragments will be found in the intestines. In one of Picco's patients who lived twenty-four hours they were found in the neighbourhood of the ileo-cæcal valve, which was much inflamed *.

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[*] *Persoon,* Traité sur les Champignons comestibles, 157.

[†] *Picco*—Hist. de la Soc. &c. p. 357, 359.

[‡] Hist. de la Soc. &c. p. 357.

Of the Treatment.—The treatment of poisoning with the fungi does not call for any special observations. Emetics are of primary importance; and after the poison has been by their means dislodged, the sopor and inflammation of the bowels are to be treated in the usual way. No antidote is known. Several have at different times been a good deal confided in; but none are of any material service.

In concluding the present chapter it is necessary to take notice of a variety of poisoning, not altogether unimportant in a medico-legal point of view. A person may seem to die of poisoning with the deleterious fungi, from eating esculent mushrooms intentionally poisoned by some other vegetable or mineral poison. It must be confessed, that if the murderer is dexterous in the choice and mode of administering the poison, such cases might very readily escape suspicion, and even when suspected might not be cleared up without difficulty. The ascertaining the species of mushroom by finding others where it has been gathered will not supply more than presumptive proof of the wholesomeness of that which has been eaten; because the esculent and poisonous species sometimes grow near one another and have a mutual resemblance, so that a mistake may easily occur. Neither will the presumption be more than strengthened a little by the additional circumstances derived from the interval which elapses before the symptoms begin, from the nature and progress of the symptoms themselves, and from the morbid appearances. Some one or other of these circumstances may indeed establish the fact of poisoning with a deleterious fungus; but it is impossible that they shall ever establish satisfactorily that the fungus was naturally wholesome; and, on the whole, I suspect the only decided evidence of poisoning by some other means would be the actual discovery of another poison.

The case now under consideration is not a mere hypothetical one. *Ernest Platner* has related a very interesting example, which proves how easily poisoning of the kind supposed may be accomplished without suspicion. A servant-girl poisoned her mistress by mixing oxide of arsenic with a dish of mushrooms. She died in twenty hours, after suffering severely from vomiting and colic pains. On dissection there were found inflammation of the stomach, gangrenous spots in it, clots of blood in its contents, and redness of the intestines. Her death, however, was ascribed to the mushrooms having been unwholesome; and the real cause was not discovered till thirteen years after, when the girl was convicted of murdering a fellow-servant in a somewhat similar way by mixing arsenic with her chocolate, and then confessed both crimes [*].

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* Hist. de la Soc. &c. p. 357.

Poisonous Mosses.—It is not improbable that some of the mosses possess poisonous properties somewhat similar to those of the deleterious fungi. *Dr Winkler* of Innsbruch mentions that the *Lycopodium Selago* is used in the Tyrol in the way of infusion for killing vermin in animals; and that unpleasant accidents have been produced in man by its accidental use. Its effects appear to be sometimes irritant, but more generally narcotic in their nature [†].

[*] Quæstiones Medicinæ Forenses, 1824, p. 206.

[†] Repertorium für die Pharmacie, xiv. 311.

CHAPTER XL.

OF THE EFFECTS OF POISONOUS GRAIN.

The different sorts of grain are subject to certain diseases, in consequence of which meal or flour made from them is apt to be impregnated with substances more or less injurious to animal life. It is likewise believed, that unripe grain possesses properties which render it to a certain extent unfit for the food of man.

It is for the most part difficult to trace satisfactorily the operation of the poisons now alluded to, because they are seen acting only in times of famine and general distress, when it is not always easy to make due allowance for the effect of collateral circumstances. There is one poison of the kind, however, whose baneful influence has been so frequently and unequivocally witnessed, that no doubt now exists regarding its properties, I mean *Spurred Rye*, or *Secale cornutum*. It is a poison of little consequence, perhaps, to the English toxicologist; for indeed I am not aware that a single instance of its operation has hitherto been observed in Britain *. But its effects are so singular, and the ravages it has often committed on the continent have been so dreadful, that a short account of it cannot fail to interest even the English reader. Besides, it has lately been introduced into the Materia Medica, as possessing very extraordinary medicinal qualities; and since its use is gaining ground, every medical jurist ought to be conversant with its properties as a poison.

Of Poisoning with Spurred Rye.

Spurred Rye, or *Secale cornutum*, the *Seigle Ergoté*, or *Ergot* of the French, and *Mutterkorn*, or *Roggenmutter* of the Germans, is a disease common to various grains, in consequence of which the place of the pickle is supplied by a long, black substance, like a little horn or spur. It has been known to attack many plants of the order Gramineæ [*], and among those used as food by man, it has been observed on barley, oats, spring-wheat, winter-wheat, and rye. But the rye seems peculiarly subject to it, almost all the poison which has caused epidemics, as well as what is now used in medicine, being produced by that grain.

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* In the Philosophical Transactions for 1762 an account is given of a family of eight people in Suffolk who all had the gangrenous form of the disease induced by spurred rye. They had lived on damaged wheat, but never used rye meal.—See *Dr Wollaston's* paper, lii. 523, and *Mr Bone's* Letter, Ibid. 526.

Of the Cause and Nature of the Spur in Rye.—The Spur attacks rye chiefly in damp seasons, and in moist clay soils, particularly those recently redeemed from waste lands in the neighbourhood of forests. Of all the places where the spur has been hitherto observed none combines these conditions so perfectly, and none has been so much infested with the disease, as the district of Sologne, situated between the river Loire and Cher, in France. According to the statistical researches of the *Abbé Tessier*, who in 1777 was deputed by the Parisian Society of Medicine to investigate the causes of the extraordinary prevalence of the ergot in that district, the country was then so much intersected by belts of wood around the fields, that the traveller in passing along would imagine he was constantly approaching an immense forest; the arable land was so poor, that, although it lay fallow every third season, it was exhausted in nine or twelve years at farthest, and then remained a long time in pasture before it could again bear white crops; the surface was so level, and consequently so wet, that crops were procured only when the seed was sown on the tops of furrows a foot high; and the climate is so moist, that from the month of September till late in spring the whole country is overhung by dense fogs [†]. Here the rye, which is the common food of the peasantry, appears to have been in Tessier's time more liable to be attacked by the spur than in any other part of the continent. *Tessier* found, that after being thrashed it contained on an average about a forty-eighth part of ergot, even in good seasons; but in bad seasons, and taking into account a considerable proportion which is shaken out of the ears and sheaves before they reach the barn, the proportion of ergot in the whole crop has been estimated so high as a fourth or even a third. In Sologne the disease was farther observed by Tessier to be always most prevalent in the dampest parts of a field, and to affect above all the first crop of fields redeemed from waste land, or from land which had previously been for some time in pasture [*]. The same connexion between moisture and the developement of the ergot has been repeatedly traced in other parts of France, and also in Germany [†]. And according to the experiments of *Willdenow*, it may be brought on at any time, by sowing the rye in a rich damp soil, and watering the plants exuberantly in warm weather [‡].

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[*] The *Phalaris canariensis* and *aquatica*, *Panicum miliaceum*, *Phleum pratense*, *Alopecurus pratensis* and *geniculatus*, *Agrostis stolonifera*, *Aira cristata*, *Poa fluitans*, *Festuca duriuscula*, *Arundo arenaria* and *cinnoides*, *Lolium perenne*, *Elymus arenarius* and *europæus*, *Triticum spelta*, *junceum* and *repens*, *Holcus avenaceus* and *lanatus*, *Dactylis glomerata*, besides those mentioned in the text.—See *Robert*, Erlaüterungen und Beiträge zur Geschichte des Mutterkorns.—*Rust's* Magazin für die gesammte Heilkunde, xxv. 8.

[†] Mémoire sur la Sologne, *in* Hist. de la Soc. Roy. de Méd. i. 61.

The spur does not seem to propagate itself by contagion. *Fontana*, indeed, has alleged that one variety of it may spread from plant to plant over a field; and even that he has expressly transmitted it by contact from one ear to another [§]. But his opinion and statement of facts are completely at variance with a set of very careful experiments lately made by *Hertwig*, a German physician, who found that even when the ear while in flower was surrounded for twelve days with powder of spurred rye, the healthiness of the future grain was not in the slightest degree affected [‖]. The same results have also been obtained by *Dr Wiggers*, the author of one of the best treatises yet published on this subject [¶].

The most precise and probable account of the cause and nature of the spur, appears to be that of *Wiggers*. It had been conceived by some that nothing else is required for its production but undue moisture combined with warmth, and that under these circumstances the spur is formed simply by a diseased process from the juices of the plant *. By others, such as *Tillet*, *Fontana*, and *Réad* it has been held to be a diseased formation, arising in consequence of the germen being punctured when young by an insect †; and in support of this statement, *General Field* says he saw flies puncture the glumes in their milky state where spurs afterwards formed, and imitating the operation with a needle obtained the same result ‡. Finally, *Decandolle*, reviving a previous doctrine that the spur is a kind of fungus, conceived he had given strong grounds for believing this excrescence to be a species of *Sclerotium*, which he terms *S. clavus* §. *Wiggers* adopts the last of these doctrines, and seems to place it on a firm foundation. He completely failed to obtain spurs in the way indicated by Field, and also in the way of inoculation mentioned by Fontana. But he found by chemical analysis, that the basis of the structure of the spur is almost identical in chemical properties with the principle fungin; and that the white dust sometimes found on the surface of the spurs will produce the disease in any plant, if sprinkled in the soil at its roots, appearing therefore to be analogous to the sporules or spawn of the admitted fungi.

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[*] Mémoire sur la maladie du Seigle appellée Ergot. Hist. de la Soc. Roy. de Méd. i. 427.

[†] *Robert's* paper, *passim*,

[‡] *Hecker's* Jahrbücher der Staatsarzneikunde, i. 240.

[§] Lettre sur l'Ergot. Journal de Physique, vii. 42.

[‖] *Lorinser* Beob. und Vers. über die wirkung des Mutterkorns, 1824, noticed in Robert's paper, p. 28.

[¶] Inquisitio in Secale cornutum, &c. Commentatio præmio regio ornata, Gottingæ, 1831. Analyzed in Annalen der Pharmacie, i. 129.

Description and analysis of Spurred Rye.—The spur varies in length from a few lines to two inches, and is from two to four lines in thickness. If it is long, there is seldom more than one or two on a single ear, and the remaining pickles of the ear are healthy. But the ears which have small spurs have generally several, sometimes even twenty; and when there are many, few of the remaining pickles are altogether without blackness at the tips ||. The substance of the spur is of a dull whitish or gray tint; and it is covered by a bluish-black or violet husk, having two, sometimes three streaks of dotted gray. It is specifically lighter than water, while the sound rye is specifically heavier, so that they are easily separated from one another ¶. It is tough and flexible when fresh, brittle and easily pulverized when dry. The powder is disposed to attract moisture.

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* *Robert* in Rust's Magazin, xxv. 20. *Tessier* seems to have been of the same way of thinking.

† *Tillet*, Dissertation sur la cause qui corrompe les blés.—*Fontana*, Lettre sur l'Ergot. Journ. de Phys. vii. 42.—*Réad*, Traité sur le Seigle Ergoté. 1771.

‡ Annals of Philosophy, N. S. xi. 14.

§ Flore Française, VI.—Robert's paper, p. 15.

|| *Tessier*, 421.

¶ *Ibid.* 428.

It has a disagreeable heavy smell, a nauseous, slightly acrid taste, and imparts its taste and smell both to water and alcohol. Bread which contains it is defective in firmness, liable to become moist, and cracks and crumbles soon after being taken from the oven *.

Spurred rye has been repeatedly subjected to analysis. The earlier researches of *Vauquelin* † and of *Pettenkofer* ‡ do not lead to any pointed results. The presence of hydrocyanic acid indicated by *Robert* §, would not account for the very peculiar effects of ergot, and has besides been denied by some, such as *Wiggers*. *Winkler* found a little gum, osmazôme, and salts of soda, and ammonia,—a modified fecula in union with colouring matter,—a thick, rancid, slightly acrid oil,—and a thick, reddish fluid, which had a disgusting empyreumatic odour, a nauseous, sweetish, acrid, lasting taste, and was composed chiefly of resin, colouring and extractive matter ‖. But he did not determine, any more than his predecessors, in which of these principles the active properties of the spur reside. *Wiggers* has lately supplied the most definite information on the subject. He denies the presence of hydrocyanic acid and of fecula, and says he found ergot to consist chiefly of a heavy-smelling fixed oil, fungin, albumen, osmazôme, waxy matter, and an extractive substance of a strong, peculiar taste and smell, in which, from experiments on animals, he was led to infer that its active properties reside. I have obtained all his chief results, except the most important of them; for the substance which ought to have been his *Ergotin* was destitute of marked taste or smell of any kind ¶.

Effects of Spurred Rye on Man and Animals.—Before proceeding to relate the effects of this poison on man, it should be mentioned, that at different times doubts have been entertained, whether the baneful effects ascribed to it did not really arise from some other cause. But, independently of the connexion which has been frequently traced between the poison and the diseases imputed to it in the human subject, the question has been set completely at rest by the experiments which have been tried on animals, and which indeed were instituted with a view to settle the point in dispute.

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* *Robert*, 28.

† Bulletins de la Soc. Philomatique, 1817, 58.

‡ *Buchner's* Repertorium für die Pharmacie, iii. 65.

§ Rust's Magazin, xxv. 43, also *Keyl*, Dissertatio de Secali Cornuto ejusque vi in corpus humanum salubri et noxia.

‖ *Rust's* Mag. für die gesammte Heilk. xxv. 47.

¶ Annalen der Pharmacie, i. 159.

The experiments hitherto made on animals are not so complete as could be wished. But they are nevertheless sufficient to show that spurred rye is an active poison of a very peculiar kind. According to the observations collected by *Dr Robert* from a variety of authors, it follows that it is injurious and even fatal to all animals which are fed for a sufficient length of time with a moderate proportion of it, unless they escape its action by early vomiting;—that dogs and cats in consequence of discharging it by vomiting, suffer only slight symptoms of irritant poisoning;—but that swine, moles, geese, ducks, fowls, quails, sparrows, as well as leeches and flies, are sooner or later killed by it;—and that the symptoms it causes in beasts and birds are in the first instance giddiness, dilated pupil, and palsy, and afterwards diarrhœa, suppurating tumours, scattered gangrene throughout the body, and sometimes dropping off of the toes. *Wiggers* ascertained that nine grains of the substance he has considered its active principle occasioned in a fowl dulness, apparent suffering, gradually increasing feebleness, coldness and insensibility of the extremities, and in three days a fit of convulsions ending in death *.

With regard to its effects on man, it has been found by express experiment, that in a single dose, two drachms for example, it excites giddiness, headach, flushed face, pain and spasms in the stomach, nausea, and vomiting, colic, purging, and a sense of weariness and weight in the limbs †. But it is not in this way that it has been usually introduced into the system; nor are these precisely the symptoms already hinted at as particularizing its action. The effects now to be mentioned form a peculiar disease, which has often prevailed epidemically in different territories on the continent, and which arises from the spur being allowed to mix with the grain in the meal, and being taken as food for a continuance of time in rye-bread. The affection produced differs much in different epidemics and even in different cases of the same epidemic. Two distinct sets of symptoms have been noticed; the one constituting a nervous disease, which is characterized by violent spasmodic convulsions, the other being a depraved state of the constitution, which ends in that remarkable disorder, dry gangrene; and it does not appear that the two affections are apt to be blended together in the same case.

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* Annalen der Pharmacie, i. 180.

† Robert's paper, p. 223, also Lorinser's Versuche, &c. of which there is an analysis in Edinb. Med. and Surg. Journal, xxvi. 453.

The first form of disease, the *Convulsive Ergotism* of the French writers, has been very well described by *Taube*, a German physician, as it occurred in the North of Germany in 1770–1. In its most acute form, it commenced suddenly with dimness of sight, giddiness and loss of sensibility, followed soon by dreadful cramps and convulsions of the whole body, *risus sardonicus*, yellowness of the countenance, excessive thirst, excruciating pains in the limbs and chest, small, often imperceptible pulse; and such cases usually proved fatal in twenty-four or forty-eight hours. In the milder cases the convulsions came on in paroxysms, were preceded for some days by weakness and weight of the limbs, and a strange feeling as of insects crawling over the legs, arms, and face; in the intervals between the fits the appetite was voracious, the pulse natural, the excretions regular; and the disease either terminated in recovery with scattered suppurations, cutaneous eruptions, anasarca or diarrhœa, or it proved in the end fatal amidst prolonged sopor and convulsions. *. Another more recent and very clear account of this form of the disease has been given by *Dr Wagner* of Schlieben from his experience of an epidemic which prevailed in the neighbourhood of that place so lately as the years 1831 and 1832. In consequence of unusual moisture and late frosts in the summer of 1831 the rye was so much spurred in many fields that a fifth at least of the pickles were diseased. As soon as the country people began to use the new rye, convulsive ergotism began to show itself, and it recurred more or less till next midsummer, when the diseased grain was all consumed. The usual symptoms were at first periodic weariness, afterwards an uneasy sense of contraction in the hands and feet, and at length violent and permanent contraction of the flexor muscles of the arms, legs, feet, hands, fingers and toes, with frequent attacks of a sense of burning or creeping on the skin. These were the essential symptoms, but a great variety of accessory nervous affections occasionally presented themselves. There was seldom any disturbance of the mind, except in some of the fatal cases, where epileptic convulsions and coma preceded death. Every case was cured by emetics, laxatives, and frequent small doses of opium, provided it was taken in reasonable time, and the unwholesome food was completely withdrawn [*].

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* *Taube*—Geschichte der Kriebelkrankheit, quoted in *Robert's* paper, p. 209.

The other form of disease, which has been named *Gangrenous Ergotism* by the French writers, and is known in Germany by the vulgar name of Creeping sickness *(Kriebelkrankheit,)* has been minutely described by various authors. In the most severe form, as it appeared in Switzerland in 1709 and 1716, it commenced, according to *Lang*, a physician of Lucerne, with general weakness, weariness, and a feeling as of insects creeping over the skin; when these symptoms had lasted some days or weeks, the extremities became cold, white, stiff, benumbed, and at length so insensible that deep incisions were not felt; then excruciating pains in the limbs supervened, along with fever, headach, and sometimes bleeding from the nose; finally the affected parts, and in the first instance the fingers and arms, afterwards the toes and legs, shrivelled, dried up, and dropped off by the joints. A healthy granulation succeeded; but the powers of life were frequently exhausted before that stage was reached. The appetite, as in the convulsive form of the disease, continued voracious throughout [†]. In milder cases, as it prevailed at different times in France, nausea and vomiting attended the precursory symptoms, and the gangrenous affection was accompanied with dark vesications [‡]. In another variety, which has been witnessed in various parts of Germany, the chief symptoms were spasmodic contraction of the limbs at first, and afterwards weakness of mind, voracity and dyspepsia, which, if not followed by recovery, as generally happened, either terminated in fatuity or in fatal gangrene [§].

These extraordinary and formidable distempers were first referred to the operation of spurred rye in 1597 by the Marburg Medical Faculty, who witnessed the ravages of the poison in Hessia during the preceding year. Since then repeated epidemics have broken out in Germany, Bohemia, Holstein, Denmark, Sweden, Lombardy, Switzerland, and France *. About the close of last century, partly in consequence of the attention of the respective governments being turned to the subject, partly by reason of the improved condition of the peasantry in these countries, and the greater rarity of seasons of famine, the epidemics became much less common and extensive. Nevertheless the creeping-sickness has been several times noticed in Germany since the present century began †.

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[*] Journal der Praktischen Heilkunde, lxxiii. iv. 3, and lxxiv. v. 71, vi. 3.

[†] Descriptio morborum ex usu clavorum secalinorum cum pane, 1717. A full extract is given of this work in *Acta Eruditorum*, *An.* 1718. *Lipsiæ*, p. 309.

[‡] *L'Abbé Tessier*, Mém. sur les effets du Seigle Ergoté. Hist. de la Soc. Roy. de Méd. ii. 611.

[§] *Robert* in Rust's Magazin, xxv. 205.

Spurred rye is now very generally believed to possess another singular quality, in consequence of which it has been lately introduced into the Materia Medica of this and other countries,—a power of promoting the contractions of the gravid uterus. This property seems to have been long familiar to the quacks and midwives of Germany; and towards the close of last century it rendered the ergot so favourite a remedy with them, that several of the German states prohibited them by severe laws from using it ‡. It was first fairly brought under the notice of regular accoucheurs by the physicians of the United States between the years 1807 and 1814 §. There appears little reason for doubting that it possesses the power of increasing the contractions of the uterus when unnaturally languid; and consequently it has been employed, apparently with frequent good effect, to hasten languid natural labour, to promote the separation of the placenta, and to quicken the contraction of the womb after delivery. These facts, however, are mentioned chiefly as preparatory to the statement, that it has been also supposed to possess the power of producing abortion, and is believed to have been actually employed for that purpose in some foreign countries. Accurate information is still much wanted on this subject. No other poison seems so likely to possess a peculiar property of the kind. Nevertheless it is the opinion of the best authorities, that Spurred Rye has no such power except in connexion with violent constitutional in-

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* *Robert* in Rust's Magazin, xxv. 200. † Ibid. 204.

‡ Robert's paper, 231, 232.

§ *Stearns* in New York Med. Rep. 1807.—*Bigelow* in New England Journal of Med. and Surg. v.—*Prescott* in Lond. Med. and Phys. Journ. xxxvi.

jury produced by dangerous doses; and that it is endowed with the property only of accelerating natural labour, not of inducing it, particularly in the early months of pregnancy.

Of Spurred Maize.—It has been already observed, that many other plants of the Natural Family of Grasses are subject to the disease of Ergot besides rye. But the only other species in which the disease has been particularly examined is the Indian corn or maize, [*Zea Mays.*] It appears from the inquiries of *M. Roullin* that maize is very subject to the spur in the provinces of Neyba and Maraquita in Colombia; that the spur forms a black, pear-shaped body on the ear in place of the pickle; and that in this state the grain, which is known by the name of *maïs peladero*, possesses properties injurious to animal life. Its effects, however, are somewhat different from those of spurred rye. Men who eat the ergotted maize lose their hair and sometimes their teeth, but are never attacked with dry gangrene or convulsions. When swine eat it, which after a time they do with avidity, the bristles drop off, and the hind-legs become feeble and wasted. Mules likewise lose their hair, and the hoofs swell. Fowls lay their eggs without the shell. Apes and parrots, which frequent the fields of spurred maize, fall down as if drunk; and the native dogs and deer experience similar effects *.

Of the Rust of Wheat.

There are several other diseases to which grain is liable, and which are much more common in this country than the Ergot. But very little is known of their effects on the animal body; which circumstance, since the wheat of this and other countries often suffers from them, is probably sufficient to show that their influence must be trifling, or at all events seldom or never called forth. Wheat is liable to three diseases. One is a disease of the stalk and leaf rather than of the ear, and has the effect of preventing the developement of the ear or its pickles, and of covering the plant with a brown powder. Of the two other diseases, which both attack the pickles of the ear, one consists in the substitution of a brown dry powder for the farina of the pickle, and the other of a deposition of black moist matter in the fissure of the pickle, the substance of which it also invades and partially destroys. One of these is called in Scotland *brown rust*, the other *black rust*.

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* Revue Médicale, 1829, iii. 332.

Of the three diseases the only one which is apt to infect the flour is the black rust. The others, as they consist of a light dry powder, are almost entirely separated in thrashing and winnowing the grain. But the black rust being damp and adhesive, it is carried along with the pickles. Such pickles are almost invariably separated by the farmer if they are abundant; for otherwise, on account of the dark colour and disagreeable odour of the matter deposited on them, the flour possesses external qualities which would be at once recognized by a dealer of ordinary experience.

It is not improbable that a moderate impregnation of bread with the powder formed by the diseases in question may take place without leading to any unpleasant effect on the human body. Experiments to this effect were made by *Parmentier* with one of them, termed in France *carie*, or caries of wheat, which from his description appears to be the black rust of Scottish farmers. He gave two dogs each two drachms daily of the powder for fifteen days without remarking any sign of ill health. Bread made with wheaten flour containing a 64th of the powder and eaten by various people, (Parmentier among the rest), to the amount of a pound daily for several days, caused slight headach and pain in the stomach the first day only; and in a larger proportion it had as little effect *.

It appears, then, that the introduction of any deleterious ingredient into wheaten bread is hardly to be dreaded from the common diseases to which wheat is liable in this country.

Of Unripe Grain.

Wheat and other grains have been supposed to acquire qualities detrimental to health, from being cut down while unripe, or used immediately after being cut down, although ripe. I am not aware that accidents have ever been traced or even imputed to such causes in this country; and, on the whole, I believe it is generally considered here that the imperfect ripening of the pickle rather lessens the quantity than impairs the quality of the flour. But several times epidemics have been ascribed in France to unripe wheat. In 1801 *M. Bouvier* read a memoir to the Society of Medicine at Paris, ascribing to the effects of new and unripe wheat an epidemic dysentery, which laid waste several districts of the department of the Oise in the autumn of 1793. These districts abound in small farms of a few acres, on the produce of which the cultivators depend in great measure for their subsistence. Hence in unfavourable seasons the corn was commonly cut down before it was ripe, and made into bread soon after being reaped. It was accordingly among the peasantry of these farms only, and not among the agriculturists of the large farms, which were under better management, that the epidemic prevailed. Bouvier remarks, that at all times when the long continuance of wet weather has compelled the inhabitants of a district to cut down the wheat before it is ripe, or a previous dearth has forced them to use it when newly cut, epidemic disorders of the bowels have been observed to rage in the latter months of autumn. And as an instance of this he refers to the year 1783, when the crops around Paris were believed to have been injured by the extraordinary prevalence of fogs, and were cut down unripe and used immediately. Various epidemics broke out in the metropolis, and still more in the surrounding country *. This is an important subject for farther inquiry; but at present I cannot help thinking that *M. Bouvier* exaggerates the effects of the immaturity of the grain. At all events, the grain is often cut down in an unripe state in various districts of this country; and I have never heard that any epidemic diseases were produced. When M. Bouvier witnessed the epidemic of 1793 in the department of the Oise, he instructed the inhabitants of his own parish to dry the unripe corn before thrashing it, to repeat the process before the grain was converted into flour, and to mix with the flour a larger quantity than usual of yeast in making it into bread; and he states that in the succeeding year, which was even more unfavourable to the crops, they were enabled, by following these directions, to use the unripe corn with safety.

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* Hist. de la Soc. Roy. de Méd. i. 346.

Of Spoiled Bread.

This is the fittest opportunity for noticing certain injurious effects sometimes observed from the use of spoiled or mouldy bread. On the continent repeated instances have occurred of severe and even dangerous poisoning from spoiled rye-bread, barley-bread, and even wheat-bread. Several instances have been observed of horses having been killed in a short space of time with symptoms of irritant poisoning after eating such bread with their ordinary food *. And *Dr Westerhoff* has given an account of its effects on two children and several adults. In children the symptoms were redness of the features, dry tongue, frequent, weak pulse, violent colic pains, urgent thirst and headach, and subsequently vomiting and diarrhœa, alternating with great exhaustion and sleepiness. The bread in these instances was made of rye †.

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* *Sedillot's* Journ. Gén. de Méd. xiv. 200.

Of the Effects of Darnel-Grass.

Grain is also rendered more or less injurious by the accidental or intentional admixture of a variety of foreign substances, by which, in common speech, it is said to be adulterated. The subject of the adulteration of grain is a very important topic in medical police. But as this practice seldom imparts to the grain qualities decidedly poisonous, the consideration of it would be misplaced here. One variety, however, the accidental adulteration of flour with the seeds of the *Lolium temulentum* or Darnel-grass, calls for some notice; for it may occasion not only symptoms of poisoning, but even also death itself.

This is the only poisonous species of the natural order of the Grasses. The seeds appear to be powerfully narcotic, and at the same time to possess acrid properties. *Seeger* gave a dog three ounces of a decoction of the flour, and observed that it was seized in five hours with violent trembling and great feebleness, which were succeeded in four hours by sopor and insensibility; but it recovered next day ‡.

When mixed with bread and taken habitually by man, Darnel-grass has been known to cause headach, giddiness, somnolency, delirium, convulsions, paralysis, and even death. *M. Cordier* found by experiment on himself, that very soon after eating bread containing Darnel-grass-flour, he felt confusion of sight and ideas, languor, heaviness, and alternate attacks of somnolency and vomiting. The bread was commonly vomited soon after he ate it*. *Seeger* has related some cases in which the somnolency was much more deep; and states that general tremors are almost always present†. A few years ago almost the whole inmates of the Poor's House at Sheffield, to the amount of eighty, were attacked with analogous symptoms after breakfasting on oatmeal porridge; and it was supposed that the meal had been accidentally adulterated with the Lolium. The chief symptoms were a piercing stare, violent agitation of the limbs, quivering of the lips, frontal headach, confusion of sight, dilated pupil, small tremulous pulse, twitches of the muscles, and palpitation. In twelve hours all of the persons attacked were well but two, who had strong convulsions in the subsequent night, but also eventually recovered ‡. A similar accident is mentioned by *Perleb*, as having happened at Freyburg in the House of Correction. The inmates, soon after eating bread made with new flour, were attacked to the number of forty, with loss of speech and somnolency; and for some days afterwards they complained of sickness §. The accident was ascribed to Darnel-grass.

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* Journal de Chimie Médicale, viii. 558.

† Ibidem, vii. 122.

‡ *Orfila*, Toxic. Gén. ii. 466, from *Seeger*, Diss. Inaug. *Tubingæ*, 1760.

Sometimes this poison appears to excite symptoms of intestinal irritation without acting as a narcotic. A small farmer near Poitiers in France saved five bushels of the seed from a field of wheat,—had it ground with a single bushel of wheat, and afterwards made bread with the mixture for his own family. He himself, with his wife and a servant, began to eat the bread on a Thursday; but the two last were so violently affected with vomiting and purging, that they refused to continue taking it. He persevered himself, however, till on the Sunday evening he became so ill that his wife wished to send for medical aid. This he refused to allow, and next day he expired after suffering severely from fits of colic ||.

Of the Effects of certain Poisonous Leguminous Seeds.

Among the injurious substances with which various grains are apt to be accidentally mixed from their growing together,

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* Sur les Effets de l'Ivraie.—Nouv. Journ. de Méd. vi. 379.

† *Orfila*, Toxicol. Gén. ii. 466.

‡ London Med. and Phys. Journal, xxviii. 182.

§ *Buchner's* Toxikologie, 174.

|| Hist. de la Soc. Roy. de Méd. ii. 297.

two leguminous plants may be here shortly mentioned, as they have often been the source of disagreeable accidents on the continent.

In the Department of the Cher and Loire in France severe effects have been lately traced to bread made partly with flour of the *Lathyrus cicera*. *M. Desparanches*, in a report to the Prefect of the Department, says this flour occasionally forms one-half of that of which bread is made in some parishes; that it produces sometimes sudden incapability of walking, sometimes imperfect paraplegia and pain, in consequence of which the gait becomes draggling and with the toes turned in, and sometimes also slight convulsive movements of the thighs and legs *. Similar effects have been traced to this substance formerly. *Virey* says it has been known to produce in particular a singular stiffness and state of semiflexion of the knee-joint, compelling the individual to move the limbs in one rigid mass †.

The *Ervum ervilia*, or Bitter vetch, which is not a native of this country, has also been found in France to possess analogous properties. In 1815, according to Virey, a great quantity of herbs grew up with the grain, in consequence of the wetness of the summer; and their seeds were thus subsequently mixed with the wheat and rye. Among these he particularizes the Ervum ervilia as peculiarly noxious, because it produces so great weakness of the extremities, but especially of the limbs, that the individual trembles while standing, and totters when he walks, or even requires the help of stilts; and he adds, that horses are similarly affected, so as to become almost paralytic ‡.

The *Cytisus laburnum*, or common Laburnum, is another plant of the same family which yields poisonous seeds. Its deleterious properties are well known to the vulgar of this country; and I have been informed of accidents having happened in this city which fully prove that it is a poison of no little energy. I have not been able to obtain the particulars of these cases, but the symptoms are commonly understood to associate the laburnum seeds with the narcotico-acrids. In two cases, however, which have been communicated to me by my colleague *Dr Traill*, the effects seem to have been almost purely narcotic. In one of these, that of a child two years old, the first evident effects were sudden paleness and a fit of screaming followed immediately by insensibility, and then by coldness of the whole body and lividity of the face; but vomiting having been induced by warm water and mustard, the seeds were discharged, the symptoms abated, and next day he was quite well. In the other instance a boy was left by his companions at Dr Traill's door in a state of complete insensibility with froth at the mouth and a feeble pulse. An emetic was immediately administered and brought up a large quantity of laburnum seeds; after which the pulse became firmer, and sensibility quickly returned. The accidents produced by it have been chiefly owing to children foolishly eating the seeds; which, considering their nauseous bitter taste, one could scarcely expect any child to attempt.—*MM. Chevallier* and *Lassaigne* have discovered in these seeds an active principle called Cytisin, a nauseous, bitter, brownish-yellow, neutral, uncrystallizable substance, of which small doses killed various animals amidst vomiting and convulsions, and eight grains taken by man in four doses brought on giddiness, violent spasms, and frequency of the pulse, lasting for two hours, and followed by exhaustion [*].

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* Nouvelle Bibliothèque Méd. iii. 439.

† Journal de Pharmacie, ii. 397.

‡ Ibidem.

A great number of *Brown's* division Papilionaceæ of the present natural family probably possess similar properties.

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[*] Journal de Pharmacie, iv. 340, 554.

CHAPTER XLI.

OF POISONING WITH ALCOHOL, ETHER, AND EMPYREUMATIC OILS.

THE last groupe of the Narcotico-Acrids comprehends *Alcohol*, *Ether*, and the *Empyreumatic Oils*.

Of Poisoning with Alcohol.

Of its Action on Animals, and Symptoms in Man.—Alcohol has been generally believed, since the experiments of *Mr Brodie*[*], to act on the brain through the medium of the nerves, and to do so without entering the blood. This may be doubted. At least in some experiments performed several years ago by *Dr C. Coindet* and myself it appeared to act not so swiftly, but that absorption might easily have taken place before its operation began. At all events, however, through whatever channel it may operate, there is little doubt that it enters the blood; for in man the breath has a strong smell of spirit for a considerable time after it is swallowed. *Professor Orfila* found that alcohol is a violent poison when injected into the cellular tissue; and that it produces through that channel the same effects as when taken into the stomach[†]. In the course of our experiments *Dr C. Coindet* and I found that it acted with great rapidity when injected into the cavity of the chest.

Authors who have treated of the action of alcohol and spirituous liquors on man, have distinguished three degrees in its immediate effects.

1. When the dose is small, much excitement and little subsequent depression are produced.

2. When the effect is sufficiently great to receive the designation of poisoning, the symptoms are more violent excitement, flushed face, giddiness, confusion of thought, delirium, and various mental affections, varying with individual character, and too familiar to require description here. These symptoms are soon followed by dozing and gradually increasing somnolency, which may at length become so deep as not to be always easily

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[*] Philosophical Transactions, ci. 118.

[†] Toxicol. Gén. ii. 451.

broken. After the state of somnolency has continued several hours, it ceases gradually, but is followed by giddiness, weakness, stupidity, headach, sickness, and vomiting.

This degree of injury from alcohol may prove fatal, either in itself, by the coma becoming deeper and deeper,—or more frequently from the previous excited state of the circulation causing true apoplexy in a predisposed habit,—or still more frequently from the occurrence of some trifling accident, which in his torpid state the individual cannot avoid or remedy, such as exposure to cold, falling with the face in mud or water, suffocation from vomited matters getting into the windpipe, and the like.

Of simple poisoning by the gradual increase of coma the following judicial case in which I was consulted is a characteristic example. Two brothers drank in half an hour three bottles of porter, into which three half-mutchkins (24 ounces) of whisky had been secretly mixed by a companion, whose object was to fill them drunk by way of joke. In the course of drinking both became confused. In fifteen minutes after finishing the last bottle one of them fell down insensible, and had no recollection of what happened for twelve hours; but he recovered. The other staggered a considerable distance for an hour, and then became quite insensible and unable to stand. In four hours more consciousness and sensibility were quite extinct, the breathing stertorous and irregular, the pulse 80 and feeble, the pupils dilated and not contractile, and deglutition impossible. In this state he remained without any material change till his death, which took place in fifteen hours after he finished his debauch. A surgeon saw him when he had been five hours ill, but did little for his relief, as the case appeared hopeless.

There is a singular variety in the principal symptoms of this form of poisoning even when completely formed. From a careful tabular analysis of no fewer than twenty-six cases, chiefly of the present denomination, collected by *Dr Ogston* of Aberdeen, from the experience of the police-office there, it appears that when the stage of stupor is fully formed, the person is sometimes capable of being roused, sometimes immoveably comatose for a long time,—that the pulse is sometimes imperceptible or very feeble, sometimes distinct or even full, generally slow or natural, seldom frequent, very seldom firm,—that the pupils are occasionally contracted, much more generally dilated, and in a few instances alternating between one state and the other,—that the countenance is commonly pale, sometimes turgid and flushed,—and that the breathing is for the most part slow, commonly soft, yet not unfrequently laborious, but very rarely stertorous. Convulsions are rare, having been observed twice only, and on both occasions in young people of the age of twelve or fourteen *. *Dr Ogston* has tried to groupe these several symptoms together in classified cases; but the general conclusions at which he arrives are subject to important exceptions. Neither do any of the special symptoms seem to bear a marked relation to the ultimate event. It is peculiarly worthy of remark, that very many cases got well where the pupils were much dilated, the coma profound, and the pulse imperceptible.

In the present form of poisoning with alcoholic fluids, it usually happens that if the stage of stupor be completely overcome, recovery speedily ensues, without any particular symptom except headach, giddiness, sickness, and the customary consequences of a debauch. But on some occasions it is observed that the comatose stage is succeeded by one which indicates much cerebral excitement,—by flushed face, injected eyes, restlessness, a febrile state of the pulse, and delirium, which is at times violent. In other cases this affection puts on very much the characters of a slight attack of typhoid fever.

In the second variety of the second degree of intoxication, an apoplectic disposition is called into action by the excited state of the circulating system; and death ensues from apoplexy rather than from simple poisoning. Thus in some instances, as will be more fully mentioned under the head of the morbid appearances, extravasation of blood is found within the head after death, preceded by the usual phenomena of ordinary intoxication. As this is a rare effect of intoxication, it must be considered as the result of poisoning with spirits, exciting apoplexy in a predisposed constitution. In like manner some cases of intoxication end in apoplectic stupor, which continues, with all the characters of apoplexy, for two days and upwards, and then terminates fatally, without extravasation being produced. Here, too, the poison operates by developing a constitutional tendency to congestive apoplexy. Again, this mode of action is still more clearly shown in some cases, where an interval of returning health occurs between the immediate narcotic effects of the poison and the ultimate apoplectic coma which is the occasion of death. Such a course of events, which, however, is of rare occurrence, is well exemplified in the following case. A man drank two pints (32 ounces) of rum one afternoon, and was comatose most of the ensuing night. Next morning, though very drowsy, he was sensible when roused; and in the evening he was considered convalescent. But two days afterwards he became delirious; in two days more he died comatose; and congestion was the only appearance found in the brain *.—All these forms of the effects of drinking ardent spirits can scarcely be considered as simple poisoning, but as the result of poisoning developing a tendency to apoplexy.

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* Edinburgh Med and Surg. Journal. xl. 277.

The third variety of poisoning with spirits in the second degree proves fatal, not in itself, but by some trivial accident happening, from which the individual cannot escape on account of his insensibility and powerlessness. Thus, it is no uncommon thing for persons in a state of deep intoxication to fall down in an exposed place, where they perish from cold, or to tumble with the face in a puddle, and so be suffocated, or to be choked by inhaling the contents of the stomach imperfectly vomited, or by lying in such a posture that their neckcloth produces strangulation. These statements are so familiar, that it is unnecessary to illustrate them by special facts.

In cases of simple poisoning in the second degree the progress of the symptoms is on the whole remarkably uniform, gradual and uninterrupted. But there are likewise some anomalies which it may be well to notice.—Thus occasionally after the phenomena of ordinary intoxication have gone on gradually increasing without having attained a very great height, sudden lethargy supervenes at once, and may prove fatal with singular rapidity. My colleague, *Dr Alison*, has communicated to me the particulars of a case of the kind where death took place from simple intoxication, twenty minutes after the state of lethargy began. The individual reached his home in a state of reeling drunkenness, but able to speak and give an indistinct account of himself. He then became lethargic, and died in the course of twenty minutes. On examining the body, Dr Alison could not discover any morbid appearance, except some watery effusion on the surface of the brain and in the ventricles; but the contents of the stomach had a strong smell of spirits. Instances of such excessive rapidity, however, are rare, unless from the third form of poisoning.—An anomaly of a different kind, of which a remarkable example was brought judicially under my notice, is sudden supervention of deep insurmountable stupor, without the usual precursory symptoms, yet not till after a considerable interval subsequently to drinking. In May 1830, a lad of sixteen, in consequence of a bet with a spirit-dealer, swallowed a mutchkin (16 ounces) of whisky in the course of ten minutes, and, pursuant to the terms of the wager, walked up and down the room for half an hour. He then went into the open air, apparently not at all the worse for his feat; but in a very few minutes, while in the act of putting his hand into his pocket to take out some money, he became so suddenly senseless as to forget to withdraw his hand, and so insensible that his companions could not rouse him. A surgeon, who was immediately procured, contented himself with giving several clysters, and a dose of tartar emetic, which did not operate; and the young man died in the course of sixteen hours. The cause of the retardation of the symptoms was partly perhaps that he had taken supper only an hour before drinking the spirits, but chiefly, I presume, because the stupor was kept off for a time by the stimulus of determination to win his bet.—Several cases somewhat similar have been described by *Dr Ogston.* In these sudden insensibility came on while the individuals were engaged in a debauch, and had been drinking freely for some time without showing any marked sign of approaching intoxication *. The cause of the postponement and sudden invasion of the stupor does not exactly appear; but a familiar cause of its abrupt invasion in ordinary cases of drunkenness is sudden exposure to cold.

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* *Cooke* on Nervous Diseases, i. 219.

It is impossible to fix the extremes of duration of the present form of poisoning in fatal cases. For, on the one hand, one or other of the accidents mentioned above may bring the case to a speedy close; and, on the other hand, the supervention of apoplexy may protract it to several days. The ordinary duration in fatal cases seems to be from twelve to eighteen hours.

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* Edin. Medical and Surg. Journal, xl. 278.

3. The third degree of poisóning is not so often witnessed, because in order to produce it a greater quantity of spirits must be swallowed pure and at once than is usually taken by those among whom poisoning in the second degree chiefly occurs. When swallowed in large quantity, as by persons who have taken foolish wagers on their prowess in drinking, there is seldom much preliminary excitement: coma comes on in a few minutes and soon becomes profound, as in apoplexy. The face is then sometimes livid, more generally ghastly pale; the breathing stertorous, and of a spirituous odour; the pupils sometimes much contracted, more commonly dilated and insensible; and if relief is not speedily procured death takes place, —generally in a few hours, and sometimes immediately. According to Mr Bedingfield, who witnessed many cases of poisoning with rum at Liverpool, which always follow the arrival of the West India vessels, the patient will recover if the iris remains contractile, but if it is dilated and motionless on the approach of a light, recovery is very improbable [*].

A case is briefly alluded to by *Orfila* of a soldier, who drank eight pints of brandy for a wager, and died instantly [†]. A case of the same kind is quoted by *Professor Marx* [‡]. Similar accidents occur not infrequently in this country; but I have not met with any fully described by authors. A case of the less rapid variety of the present form occurred at the Infirmary here in 1820. A man stole a bottle of whisky; and, being in danger of detection, took what he thought the surest way of concealing it, by drinking it all. He died in four hours with symptoms of pure coma.

Convulsions are not common in such cases. I have seen a remarkable example, however, in which the coma was accompanied with constant alternating *opisthotonos* and *emprosthotonos*. The subject was a boy who had been induced to drink raw whisky by an acquaintance, and had been two hours insensible before I saw him. The stomach-pump, which was immediately applied, brought away a large quantity of fluid with a strong spirituous odour; and he recovered his senses in fifteen minutes, but remained very drowsy for the rest of the day.

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[*] Edinb. Med. and Surg. Journal, xii. 489, from Bedingfield's Compendium of Med. Practice.

[†] Toxicol. Gén. ii. 454.

[‡] Die Lehre von den Giften, I. ii. 306.

Such are the forms of poisoning with spirits usually admitted by authors. But it also appears to act sometimes as an irritant. After its ordinary narcotic action passes off, another set of symptoms occasionally appear, which indicate inflammation of the alimentary canal. Cases of this kind are exceedingly rare; yet they have been met with, as the following extract shows. "A young man at Paris had been drinking brandy immoderately for several successive days, when at length he was attacked with shivering, nausea, feverishness, pain in the stomach, vomiting of everything he swallowed except cold water, thirst, and at last hiccup, delirium, jaundice, and convulsions; and death took place on the ninth day. On examining the body the stomach was found gangrenous over the whole villous coat; the colon too was much inflamed; and all the small intestines were red *."

A case of great complexity, but probably of the same nature, has been related by *Opitz* in Pyl's Memoirs. The subject was a woman liable to epilepsy, and addicted to excessive drinking. After one of her drinking-bouts she was seized with vomiting and severe pain of the bowels, afterwards with delirium, then with convulsions, and she died in twenty-four hours after the first attack. The stomach and intestines were greatly inflamed, a table-spoonful of blood was effused into the ventricles of the brain, and the left lung was purulent †.

Besides the immediately fatal effects of spirituous liquors now described, there is still another variety of poisoning more common than any yet mentioned, and constituting a peculiar disease. People who fall into the unhappy vice of habitual intoxication, after remaining in a state of drunkenness for several days together, are often attacked with a singular maniacal affection, which is accompanied with tremors of the limbs, particularly of the hands, and after enduring for several days, ends at last in coma. When the delirium is not violent, the disease by proper treatment may be cured. But frequently, after the delirium and tremor have continued mildly for some time, they increase, and the delirium becomes furious, or coma rapidly su-

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[*] *Corvisart's* Journ de Méd. xvii. 43.

[†] Aufsätze, v. 94.

pervenes; in either of which cases the disorder commonly proves fatal in two or three days more. This disease, which is now familiar to the physician, is called *delirium tremens*. It is supposed by some to depend on inflammation of the membranes of the brain, followed by effusion.

Other diseases, besides *delirium tremens*, are also slowly induced by the habitual and excessive use of spirituous liquors; but in general the habit of intoxication acts in inducing these diseases only as a predisposing cause. A particular variety of tuberculated liver probably arises from the habitual use of spirits without the co-operation of other causes. That variety of disease of the kidney which has been lately brought under the notice of the profession by *Dr Bright* [*], and which has appeared to me extremely common [†], is also obviously often connected with the habit of drinking spirits. The following have been enumerated among the diseases where the same habit acts powerfully as a predisposing cause—indurated pancreas,—indurated mesenteric glands—scirrhous pylorus,—catarrh of the bladder,—inflammation, suppuration, and induration of the kidnies,—incontinence of urine,—aneurism of the heart and great vessels,—apoplexy of the lungs,—varicose veins,—mania,—epilepsy,—tendency to gangrene of wounds,—spontaneous combustion [‡].

Of the Morbid Appearances.—Some doubts exist as to the morbid appearances in the bodies of those poisoned by overdoses of spirituous liquors.

In animals killed by alcohol, Orfila says he found the villous coat of the stomach constantly of a cherry-red colour. I have several times remarked the same appearance. When the stomach was empty before the alcohol was introduced, I have always found the prominent part of its rugæ of a deep cherry-red tint, the margin of the patches being more florid, and evidently consisting of a minute net-work of vessels.

In man these signs of irritation have not been always observed. In the patient who died in the Infirmary here, the stomach was quite natural to appearance. *Dr Ogston* notices injection of the small intestines and thickening of the mucous membrane of the stomach and intestines as common appearances in the cases he has examined; but he seems to consider these the effects not of the last fatal dose, but of the habit of frequent excessive drinking [*].

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[*] *Bright's* Reports of Medical Cases, i. 1.

[†] See also paper by *Dr Gregory* in Edin. Med. and Surg. Journal, xxxvi. 315; also a paper by myself, *Ibidem*, xxxii. 262.

[‡] See on this subject, *Grötzner*, über die Trunksucht und ihre Folgen.—*Rust's* Mag. für die ges. Heilkunde, xx. 522.

The blood in the heart and great vessels is commonly fluid and very dark, and the lungs are sometimes more or less gorged with the same fluid.

The state of the brain differs much according to the mode of death. Sometimes great congestion and even actual extravasation of blood are found in the heads of persons who have died of excessive continuous drinking,—the excitement of such a debauch being apt, as already mentioned, to induce apoplexy in a predisposed habit. Accordingly extravasation was found by *Professor Bernt* of Vienna in no less than four cases of the kind, two of which happened in the persons of young men not above twenty-two years of age [†]; and *Dr Cooke* quotes another in his work on nervous diseases [‡]. I have myself met with another remarkable instance. A female out-pensioner of Trinity Hospital here, who was much addicted to drinking, and for fourteen days after the New-year of 1830 had been very little in her sober senses, soon after arriving at home one evening much intoxicated, fell down comatose, and died in ten or twelve hours. An enormous extravasation of clotted blood was found in the ventricles, producing extensive laceration of the right middle and anterior lobes of the brain.—In such cases it is natural to suppose that a predisposition to apoplexy must concur with the intoxication; otherwise it is not easy to see why death from extravasation is not more frequently produced by excessive drinking.

Extravasation is not apt to occur in the cases of rapid death brought on by a very large quantity swallowed at once. The circulation, indeed, is during life in a state quite the reverse of excitement; and accordingly the brain and its membranes are found quite healthy. They were particularly so in the man who died in the hospital here. It is right to mention, however, that one of Bernt's cases, although the symptoms and other particulars are not mentioned, possibly belongs to the present variety, as the man swallowed for a wager a quart of brandy at a draught [*]. According to *Dr Ogston*, who has given the best account of the appearances within the head in the ordinary cases of this kind, there is usually serous effusion under the arachnoid membrane, occasionally minute injection of vessels, commonly more or less general gorging of the larger veins, and especially effusion of serosity to the amount of two or even four ounces in the ventricles [†].

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[*] Edin. Medical and Surg. Journ. xl. 292.

[†] Beiträge zur Gerichtl. Arzneik. ii. 59, iii. 38.

[‡] On Nervous Diseases, i. 219.

When delirium tremens proves fatal, effusion is commonly found among the membranes of the brain; and occasionally to a very great extent. In one instance, which proved very quickly fatal, namely, in two or three days, I have seen minute vascularity of the membranes with effusion of fibrin, and without effusion of serosity; but such cases are rare. There is also, according to Andral, very extensive softening of the mucous coat of the stomach [‡]. In an instance mentioned in *Rust's* Journal, besides effusion into the cerebral membranes, there was found an enormous accumulation of fat in all the cavities, a conversion of the muscular substance into fat, and a nauseous sweet smell from the whole body [§].

In all cases of rapid poisoning with spirituous liquors some of the poison will be found in the stomach. For when the case is one of pure narcotic poisoning, unaided by the effects of blows, exposure to cold, or the like, and the person dies in a few hours, the poison cannot be all absorbed before death.—Although the spirituous liquors used in Britain have all very powerful odours, the inspector in a case of importance ought not to confine himself to this test alone. He must subject the suspected matter to distillation from the vapour-bath; and then remove the water from what distils over by repeated agitation with dry carbonate of potass, till he procures the alcohol of the spirit in such a state of purity as to leave no doubt of its existence.

It is a singular fact, that a smell like that of alcohol is sometimes exhaled by different parts of the body. Thus *Dr Cooke* mentions a case in which the fluid in the ventricles of the brain had the smell and taste of gin, the liquor which had been taken [*]; *Dr Ogston* adverts to an instance where death was occasioned by drowning during intoxication, and where there was found on dissection "nearly four ounces of fluid in the ventricles having all the physical qualities of alcohol [†];" and in the case which occurred in the hospital here the odour of whisky was said to have been perceived in the pericardium. In a man who died of long-continued intoxication from immoderate drinking *Dr Wolff* found that the surface, and still more the ventricles, of the brain had a strong smell of brandy, although the contents of the stomach had not [‡]. In former editions of this work I have ventured to question the accuracy of such statements, on the one hand because in animals poisoned with alcohol introduced into the stomach I never could perceive the smell in any other part of the body; and on the other hand because I have several times remarked in the venous blood and brain of a fresh subject a smell which a prepossessed person might have confounded with that of alcohol, although no spirituous liquor had been taken before death. I must still repeat my doubts; chiefly, however, with the view of calling the attention of pathologists to the subject, and of expressing my surprise that those who imagine they have observed so very extraordinary a physiological fact as the transference of a spirituous fluid, not much diluted, from the stomach to the ventricles of the brain, should not have thought it indispensable to substantiate the fact in the only way in which it admits of being substantiated, namely by chemical analysis.

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[*] Beiträge zur Gerichtl. Arzneik. iii. 38.

[†] Edin. Med. and Surg. Journal, xl. 282, 284, 293.

[‡] Répertoire Gén. d'Anat. et de Physiol. Pathologique, i. 51.

[§] Magazin für die ges. Heilkunde, xxi. 522.

It is hardly necessary to add, that when the individual has survived the taking of the poison a considerable length of time, an odour of spirits will not be perceived either in the stomach or elsewhere. In the out-pensioner of Trinity Hospital, for example, who survived about twelve hours, no spirituous odour could any where be perceived. In such cases the poison disappears during life by absorption.—A question may even be entertained, whether the odour may not sometimes be imperceptible at the inspection of the body, although the poison was really present immediately after death. It is probable that, as in the instance of hydrocyanic acid, the alcohol, on account of its volatility or fluidity, will evaporate or percolate away in a few days. In this manner only can be explained the occasional absence of the odour in persons who have been killed in the early stage of drunkenness. I could not perceive any odour of whisky in the stomach of the woman Campbell who was murdered by the notorious resurrectionist Burke, although she had drunk spirits to intoxication half an hour before her death. The body was not examined till thirty-eight hours after *.

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[*] Treatise on Nervous Diseases, i. 222.—It is added that the liquid was inflammable. It would have been desirable that Dr Cooke, or rather his informer, *Sir A. Carlisle*, had mentioned how the inflammability was proved; for some fallacy may be strongly suspected; because gin of sufficient strength to take fire could not enter the blood-vessels without coagulating the blood, and so preventing its further progress.

[†] Edin. Medical and Surgical Journal, xl. 293. Dr Ogston seems to think it unreasonable to doubt such cases. But before any man's doubts are removed some better proof will be necessary than the bare statement in the text.

[‡] *Rust's* Magazin für die gesammte Heilkunde, xxv. 126.

From all that has been said there ought seldom to be much difficulty in recognizing a case of poisoning with spirituous liquors.

But before quitting the subject a form of it must be noticed which may be extremely difficult to distinguish. It was formerly remarked that the eatable mushrooms have been sometimes poisoned with substances possessing effects on the system analogous to those caused by the deleterious fungi. In the same manner spirituous liquors may be poisoned with narcotics allied to them in action. Thus in former parts of this work it has been stated that a young man was killed during a debauch in consequence of his companions having mingled opium with his wine; that many persons have been poisoned and some killed by fermented liquors drugged in the same manner; that murder has been accomplished by poisoning wine with nightshade; and that several fatal accidents have occurred in consequence of liqueurs having been too strongly impregnated with hydrocyanic acid to convert them into ratafia. Cases of this nature may be embarrassing. In general they may be made out by attending strictly to the symptoms, the quantity of the liquor taken, and the contents of the stomach. But it must be admitted, that if a murderer, who chooses such a method, should season his guest's drink judiciously and ply him well

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* Cases and Observations in Medical Jurisprudence.—Edin. Med. and Surg. Journal, xxxi. 239.

with it, a medical jurist might be puzzled to determine whether the liquor was to blame in point of quality or quantity.

Of the Treatment.—The treatment of poisoning with alcoholic fluids does not differ essentially from that of poisoning with opium. In the former, as in the latter, the chief object must be to remove the poison from the stomach and to rouse the patient from his state of stupor; but in poisoning with alcoholic fluids it is also frequently necessary to treat a secondary stage of reaction by local and even general antiphlogistic measures. As to the primary object, the removal of the poison from the stomach, it appears that in the present form of poisoning emetics are more seldom effectual than in the case of other narcotics, and that the stomach-pump should be promptly resorted to. It is remarkable that the operation of clearing out the stomach is likewise often a sufficient stimulus to dispel stupor immediately and even permanently. I have seen almost complete consciousness permanently restored with the discharge of the alcoholic fluid; and the same remark has often been made by others. Where the senses are not thus restored, one of the most effectual stimulants, according to the practice of the police-office of this city, is the injection of water into the ears. Great advantage has been derived, as in poisoning with opium, from the cold affusion applied to the head. *Dr Ogston*, who has appended to his paper formerly quoted a very useful summary of the treatment of poisoning with spirits, has found this a safe and effectual remedy where the heat of the head was unnaturally great and that of the body not too low [*]; and cases have also been published where it proved successful although the pulse was gone at the wrist, the breathing scarcely perceptible, and the temperature of the whole body greatly reduced [†]. It is doubtless a powerful remedy: but where the general temperature of the surface is much lowered, I conceive it should be restricted to the head and neck, and that it should be conjoined with the application of warmth to the body. Dr Ogston objects to the general use of blood-letting in cases of poisoning with spirits, as being often apt to be followed by sudden sinking. Where other remedies are judiciously used, it is probably seldom called for; and the purpose it is intended to serve, namely, the relief of cerebral congestion and determination, is better fulfilled by the local employment of cold, and local blood-letting. Ammonia and its acetate have been found useful as internal stimulants where the stupor is deep. The treatment of the secondary affections adverted to above does not require specific mention.

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[*] Edin. Medical and Surgical Journal, xl. 295.

[†] *Smith*, London Medical Gazette, ix. 502.

Of Poisoning with Sulphuric and Nitric Ether.

Sulphuric Ether and Nitric Ether are poisons of the same nature with alcohol. But the effects produced by them when taken in considerable doses are not very well known.

Orfila found that half an ounce of sulphuric ether introduced into the stomach of a dog and secured there by a ligature on the gullet, excited efforts to vomit, in ten minutes inability to stand, and in six minutes more, insensibility. In fifteen minutes more the animal revived a little, but soon became again comatose; and it died in three hours after the commencement of the experiment. The villous coat of the stomach was reddish-black, the other coats of a lively red colour [*].

The effects of the ethers on man have not been accurately ascertained. From some observations published in the Journal of Science, sulphuric ether appears to act energetically even in small doses. In moderate quantity it produces a strong sense of irritation in the throat, a feeling of fulness in the head, and other symptoms like those excited by nitrous-oxide gas. A gentleman, in consequence of inhaling it too long, was attacked with intermitting lethargy for thirty-six hours, depression of spirits and lowness of pulse[†]. When long and habitually used, for example by persons afflicted with asthma, its dose must be gradually increased; and it appears that considerable quantities may then be taken for a great length of time without material injury. I have been informed of an instance of an asthmatic gentleman about sixty years of age who consumed sixteen ounces every eight or ten days, and had been in the habit of doing so for many years. Yet, with the exception of his asthma, he enjoyed tolerable health.

An interesting case has been published which proves that nitric ether in vapour is a dangerous poison when too freely and too long inhaled. A druggist's maid-servant was found one morning dead in bed, and death had evidently arisen from the air of her apartment having been accidentally loaded with vapour of nitric ether, from the breaking of a three-gallon jar of the *Spiritus Etheris Nitrici.* She was found lying on her side, with her arms folded across the chest, the countenance and posture composed, and the whole appearance like a person in deep sleep. The stomach was red internally, and the lungs were gorged *. The editor of the journal where this case is related, says he is acquainted with a similar instance where a young man was found completely insensible from breathing air loaded with sulphuric ether, remained apoplectic for some hours, and would undoubtedly have perished had he not been discovered and removed in time.

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[*] Toxicol. Gén. ii. 456.

[†] Journal of Science, iv. 158.

Of Poisoning with Empyreumatic Oils.

The physiological effects of these substances have not yet been extensively investigated. It has been already mentioned that the empyreumatic oil of tobacco is an active poison, (p. 771); and that the emanations from candle snuffings and imperfectly consumed tallow, probably owe their injurious properties to a peculiar oil. Many empyreumatic oils are known, and some are used in medicine, which act powerfully on the animal system as stimulants and antispasmodics. Among these may be enumerated naphtha, beech-oil, oil of galbanum, oil of guiajac, oil of amber, oil of wax, and Dippel's oil. The last in particular, which is the rectified empyreumatic oil of hartshorn, but is prepared also from blood and various animal matters †, has been a good deal used of late on the Continent for medical purposes, and has even been resorted to as a poison for the purpose of self-destruction.

The only one of these substances whose physiological properties have been examined with particular care, is the empyreumatic oil procured by the destructive distillation of lard. When freed of adhering acid by rectification from quicklime, this oil is limpid and very volatile, has an insupportable smell, and when diffused in the air irritates the eyes and nostrils, and even excites giddiness. *Buchner* found it to possess simple narcotic properties. When a mouse was confined under a jar into which a little of its vapour was introduced, it suddenly tried to escape, immediately fell down exhausted, and, although soon afterwards removed into the open air, expired in about fifteen minutes without convulsions. It is much less powerful when introduced into the stomach, yet is still a dangerous poison through that channel; for five drops projected into the throat of a chaffinch very nearly proved fatal; and the only symptoms were excessive exhaustion, slow respiration, and insensibility [*].

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* Midland Med. and Surg. Reporter, i., or Edin. Med. and Surg. Journal, xxxv. 452.

† *Fechner's* Repertorium für Organischen Chemie, i. 1078.

Similar effects have been occasionally observed in man. The late *Professor Chaussier* has related a case of poisoning in the human subject from the oil of Dippel or rectified empyreumatic oil of hartshorn. It is merely mentioned, however, that the individual, on taking a spoonful by mistake, died immediately; and that no morbid appearance could be discovered in the dead body [†]. Another case has been more recently related where the poison was the impure oil of commerce from which the oil of Dippel is prepared by rectification. The subject was a woman who took it intentionally in the dose of an ounce and a-half. The symptoms induced could not be ascertained; but it appeared, that she had been attacked with vomiting, and, finding the action of the poison either less speedy or less supportable than she could wish, had thrown herself into a well and been drowned. The appearances in the body clearly showed that in this instance the poison had not acted as a pure narcotic. The whole body exhaled the peculiar fetid odour of the oil. The palate, tongue, throat, and gullet, were white and shrivelled. The stomach had outwardly a diffuse rose tint, crossed by gorged black veins, which here and there had burst and formed patches of extravasation. The contents of the stomach consisted of remains of food, a good deal of the oil, some water, and likewise some extravasated blood. Its villous coat was thick, covered with red points, corrugated into prominent rugæ, but not eroded. The intestines also presented signs of irritation, but in an inferior degree [‡].

These facts seem to establish sufficiently the propriety of arranging the empyreumatic oils among the narcotico-acrids.

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[*] Toxikologie, 395.

[†] Diction. des Scien. Méd. xxi. 605.

[‡] Journal Universel. Novembre 1829.

Oil of turpentine possesses somewhat similar properties; but is much less active. It was found by *Professor Schubarth*, that two drachms of this oil administered to a dog produced immediate staggering, cries, tetanus, failure of the pulse and breathing, and death in three minutes; and in the dead body he remarked flaccidity of the heart, gorging of the lungs and redness of the stomach [*]. It is likewise well known to be a powerful poison for vermin, such as lice, fleas, and worms.—On man its effects are capricious. It is frequently used along with other laxatives against obstinate constipation of the bowels, and either in the same manner or alone as a remedy for intestinal worms. For these purposes it has been at times administered in very large doses, for example in the quantity of two, three, or four ounces, without any other effect than brisk purging. But on the other hand it has sometimes, in much inferior doses, induced violent hypercatharsis, or acted severely on the urinary organs, producing strangury and bloody micturition, or affected the brain, producing a state like intoxication, followed by trance for many hours [†]. I am not aware that it has ever proved fatal.

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[*] Horn's Archiv für Med. Erfahrung, 1824, i. 89, 91.

[†] *Duncan's* Dispensatory, 12th Edition, p. 552.

CHAPTER XLII.

OF COMPOUND POISONING.

Having now investigated the three great classes of poisons in their relations to physiology, practice of physic, and medical jurisprudence, it will be necessary for me to offer a few observations on a subject of considerable medico-legal importance, which has been almost entirely overlooked in systems of Toxicology,—Compound Poisoning.

When two poisons of different or opposite properties are administered about the same time in poisonous doses, the effects of the one may overpower and prevent the operation of the other, or they may merely modify the action of one another. In this manner the usual symptoms produced by one or by both may be entirely or in a great measure wanting; and even in the dead body the usual appearances occasioned by one or by both may be modified or perhaps altogether absent.

Although in the course of reading I have met with a sufficient number of cases of the kind to shew that compound poisoning is an object of some consequence to the medical jurist, the facts hitherto made public are not so numerous as to render a systematic arrangement of them practicable. The most advisable course, therefore, seems to be merely to describe for the present the cases which have been brought under my notice. These are as follows.

1. *Poisoning with Arsenic and Alcohol.*—A man, after taking three gills (12 ounces) of whisky at a debauch, swallowed, an hour afterwards, while in a state of excitement, but not particularly drunk, a quantity of arsenic, the dose of which could not be ascertained. Fifteen minutes after the arsenic was taken medical aid was procured, upon which repeated attempts were made to produce vomiting by means of ipecacuan and sulphate of zinc, but to no purpose. The stomach-pump was therefore resorted to; and, after at least an hour had been spent in previous attempts by emetics, the stomach was cleared of a fluid in which arsenic was unequivocally detected. No symptom of poisoning with arsenic followed. As the man took the arsenic

seven hours after a meal, when of course the powder would at once be brought freely in contact with the villous coat of the stomach, it must, I think, be inferred that the operation of the arsenic was impeded or prevented by the narcotism previously induced by the ardent spirits. For this case I am indebted to a late pupil Mr King.

2. *Poisoning with Arsenic and Alcohol.*—A case of the same description with the last, but which proved fatal in consequence of the large quantity of arsenic taken, has been related by *Dr Wood* of Dumfries. A lad of seventeen, after a night's debauch, swallowed half an ounce of arsenic early in the morning. In two hours and a-half, when Dr Wood first saw him, there was no symptom of poisoning with arsenic,—no symptom at all indeed but languor and drowsiness. A few minutes afterwards he had slight vomiting, which was repeatedly renewed by artificial means. For some hours the pulse was but little elevated. In eighteen hours he began to sink, and presented the usual constitutional symptoms of poisoning with arsenic; and in forty-one hours he expired. But from first to last he had scarcely any local symptom except vomiting, even although the stomach presented after death signs of violent irritation [*].

3. *Poisoning with Tartar Emetic and Charcoal Fumes.*—Under the head of poisoning with antimony, notice has already been taken of the case of a man who, after swallowing seventeen grains of tartar emetic, attempted to commit suicide by suffocating himself with the fumes of burning charcoal. He recovered from both attempts, suffered severely from the usual narcotic effects of carbonic acid gas, but showed scarcely any symptom of the irritant operation of tartar emetic [†].

4. *Poisoning with Alcohol and with Laudanum.*—Under the head of poisoning with opium, allusion has already been made to a remarkable case related by Mr Shearman, where the usual effects of opium were much retarded in an individual who, at the time of swallowing the opium, was in a state of excitement from intoxication. For five hours there was no material stupor. But after that the usual narcotic symptoms supervened and eventually proved fatal [‡]. The excitement of intoxication,

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[*] Edin. Med. and Surg. Journal, xxxiii. 61.

[†] Journal Universel des Sc. Méd. xvii. 120.

[‡] London Med. and Phys. Journal, xlix. 119.

however, has not always the effect of suspending the action of opium; for in a case which came under my notice in the Infirmary of this city,—that of a woman, who swallowed an ounce and a-half of laudanum while much intoxicated,—the usual narcotic symptoms were fully formed in an hour: and although the stomach-pump was applied soon afterwards, she expired in less than five hours from the time the laudanum was swallowed,—those who had charge of her before she was brought into the hospital having neglected to use the proper means for keeping her roused.

5. *Poisoning with Laudanum and Corrosive Sublimate.*—Of all the cases of compound poisoning I have met with, the most remarkable is an instance which occurred in Edinburgh Castle, a few years ago, of poisoning with laudanum and corrosive sublimate. In this case, the individual, a young soldier, swallowed about the same time two drachms of the latter and half an ounce of the former. He had at first no violent symptoms whatever indicating the operation of corrosive sublimate: which is an extremely rare occurrence. Afterwards he had frequent purging and tenesmus, with bloody stools and all the usual phenomena of violent dysentery, but no pain of belly, no tenderness even on firm pressure, no vomiting except under the use of emetics. On the fourth day a violent salivation set in; and under this and the dysenteric affection he became quickly exhausted, yet not so much, but that on the day of his death, the ninth after he took the poison, he was able to walk a little in his room without assistance. He died on the close-stool rather unexpectedly. I have unfortunately lost the original notes I had of this case, and have forgotten whether any narcotic symptoms were present at first; but my impression is that they were present, though in a slight degree only. For most of the previous particulars I am indebted to *Dr Mackintosh.* The stomach, duodenum, ileum, colon, and rectum were found after death enormously inflamed, ulcerated, and here and there almost gangrenous.—In this instance some of the corrosive sublimate must have been decomposed by the laudanum, and an insoluble meconate of mercury formed. But the quantity thus decomposed could have been but a small proportion of the whole, —as was indeed proved by the extensive ravages actually committed in the whole alimentary canal. I conceive, therefore,

that there is no other way of accounting for the slight apparent effects of the corrosive sublimate, at the commencement particularly, than by supposing that the narcotic operation of the opium veiled or actually retarded the irritant action of the corrosive sublimate.

6. *Poisoning with Opium and Belladonna.*—A lady, who used a compound infusion of opium and belladonna as a wash for an eruption in the vulva, took it into her head one day to use the wash as an injection; and actually received three successive injections, containing each the active matter of a scruple of opium and half an ounce of belladonna leaves. Fortunately none of the three was retained above a few minutes, except the last, which was not discharged for ten minutes. In less than an hour, she was found in bed in a deep sleep, but the true cause was not suspected till three hours later. She was then completely insensible and motionless, with the face pale, the pupils excessively dilated and not contractile, the pulse frequent and small, and the breathing hurried. After the use of purgative injections, blood-letting, leeches to the head, and sinapisms to the legs, she began in five hours to show some sign of returning consciousness, which improved after a fit of vomiting. When thoroughly roused, the vision continued dim with the pupils excessively dilated, and the ideas somewhat confused. For three days after the pulse continued frequent, and the pupils somewhat dilated *. Here the opium seems to have prevented the delirium usually induced by belladonna in the early stage, while on the other hand the belladonna prevented the usual effect of opium on the pupils, and actually produced the opposite action.

7. In the following cases, the active poisons to which the individuals were exposed were so numerous, that it is impossible to say which or how many of them occasioned the symptoms. A colour-maker was superintending a process in which cobalt, arsenic, mercury, sal-ammoniac, and nitric acid were subjected to heat in a mattrass, when the mattrass suddenly gave way, and a dense vapour was instantly discharged. The manufacturer, before he could escape, fell down insensible; and though speedily removed, he died in no long time, affected with enormous swelling of the abdomen. A workman who was also present, escaped by a window; but was nevertheless immedi-

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* *Martin Solon.* Journal Hebdomadaire, viii 73.

ately attacked with swelling of the belly, which speedily became very great, and was attended with pain in the jaws, and dimness of sight. These symptoms were very slowly dissipated under the use of colding bathing and purgatives, which brought away an enormous quantity of fetid gas *.

These are not the only examples of compound poisoning which have come under my attention. But others I have noticed are not detailed with sufficient exactness to make it worth while to quote them. The instances given, however, are sufficient to show that poisons of opposite qualities given about the same time in large doses will disguise one another's effects, or impede, or perhaps even prevent them, in a manner which renders such a combination of circumstances an important subject of inquiry for the medico-legal toxicologist.

It is probable that the modifying influence is established in one of two ways,—either by one poison producing a state of venous plethora or distension, which impedes, or for a time prevents, the absorption of the other,—or by one poison producing an insensibility of the membrane with which the other is in contact; so that not only the local injury actually done has not the usual remote effect on the constitution, or on distant organs, but likewise is at times substantially less extensive than in ordinary circumstances. These reflexions arise naturally from a review of the preceding cases; but of course farther facts are necessary to give them weight.

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* *Gueneau de Mussy.* Archives Gén. de Méd. Deuxième Série, i. 594.

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4. A small glass funnel for introducing the material into the tube Fig. 1, without soiling its inside.
5. The ordinary apparatus for disengaging sulphuretted-hydrogen. The funnel must be a little longer than the emerging tube. The fluid should not be at any time much higher than in the figure, in order to secure the operator against its effervescing up into the emerging tube. The figure is a third of the natural size.
6. Instrument for washing down scanty precipitates on filters. It is a thin bottle capable of standing the fire—half-filled with water, which may be boiled on occasion,—and having its cork pierced with a small tube drawn at its outer end to a very fine bore. The breath is impelled into the bottle, and, the bottle being then reversed, a very fine stream issues with great force. This exceedingly useful and simple apparatus is the invention, I believe, of Berzelius.
7. Tubes of natural size for collecting small portions of mercury by the process, p. 343.
8. Pipette, one-third the natural size, for removing by suction fluids lying over precipitates. Some have a rectangular bend in the upper part, by means of which the operator sees better the point of the instrument when in action; but such pipettes are very difficult to clean. That represented in the figure is easily cleaned with a feather.
9. Apparatus for reducing the sulphurets of some metals by a stream of hydrogen. A, the vessel with zinc and diluted sulphuric acid, the latter of which may be renewed by the funnel B. C, a ball on the emerging tube to prevent the liquid thrown up by the effervescence from passing forward. D, E, corks by which C and G are fitted into F, the tube which contains the sulphuret at F. G, the exit-tube for the sulphuretted-hydrogen, plying into a vessel containing acetate of lead. When the hydrogen has passed long enough to expel all the air, the spirit-lamp flame is applied at F.; and when sulphuretted-hydrogen is formed, the lead solution is blackened. The figure is one-third the size of the apparatus.

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